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GULF OF MEXICO OCS REGION

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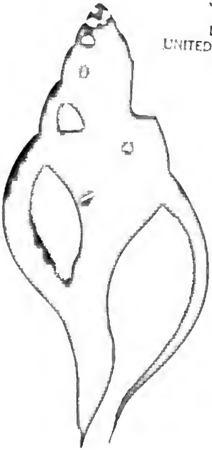

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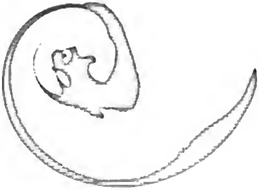

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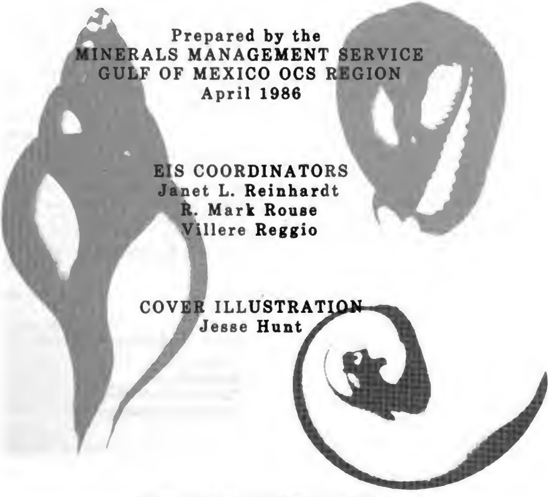

Prepared by the
MINERALS MANAGEMENT SERVICE
GULF OF MEXICO OCS REGION
April 1986

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REGIONAL DIRECTOR'S NOTE

The Environmental Impact Statement (EIS) covering the proposed OCS oil and gas lease sales in the Gulf of Mexico for 1987 is a product of the Minerals Management Service (MMS) in Metairie, Louisiana. This document discusses the purpose and background of the proposed actions, the alternatives including the proposed actions, the description of the affected environment, and the environmental impacts of proposed Central Gulf of Mexico Sale 110 (April 1987) and Western Gulf of Mexico Sale 112 (August 1987). Visuals referenced in the document were distributed with Final EIS 94/98/102. If additional visuals sets are needed, they may be obtained from the address below until supplies are exhausted.

This document makes considerable reference to the Final Regional Environmental Impact Statement (Final Regional EIS), the Final Environmental Impact Statement for the 1984 Lease Offerings (Final EIS 81/84), the Final Environmental Impact Statement for the 1985 Lease Sales (Final EIS 94/98/102), and the Final Environmental Impact Statement for the 1986 Lease Sales (Final EIS 104/105). Copies may be obtained from the MMS, Gulf of Mexico OCS Regional Office, Imperial Office Building, 3301 N. Causeway Blvd., Metairie, Louisiana or by mail from MMS, Post Office Box 7944, Metairie, Louisiana 70010.

J. Rogers Pearcy

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Regional Director
Gulf of Mexico OCS Region
Minerals Management Service

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COVER SHEET

Environmental Impact Statement for Proposed Central Gulf of Mexico OCS Lease Sale 110 (April 1987) and Proposed Western Gulf of Mexico OCS Lease Sale 112 (August 1987)

Draft (x) Final ( )

Type of Action:

Administrative (x) Legislative ( )

Area of Potential Impact:

Offshore Marine Environment and Coastal Counties/Parishes of Alabama, Mississippi, Louisiana, and Texas

Lead Agency:

U.S. Department of the Interior
Minerals Management Service
Gulf of Mexico OCS Region

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SUMMARY

The Proposed Actions

Central Gulf of Mexico OCS Lease Sale 110 (April 1987) from the Department of the Interior's Final 5-Year OCS Oil and Gas Leasing Schedule (July 1982) and Western Gulf of Mexico OCS Lease Sale 112 (August 1987) from the Proposed 5-Year OCS Oil and Gas Leasing Program (announced February 1986) are considered separate proposals.

The proposed action for Sale 110 (April 1987) will offer for lease all unleased acreage in the Central Planning Area (CPA) which amounts to approximately 31.4 million acres or 5,821 blocks as of December 1985 (Figure I-1). Unleased blocks are located from approximately 3-220 miles offshore in water depths ranging from approximately 4 m to 3,200 m.

The proposed action for Sale 112 (August 1987) will offer for lease all unleased acreage in the Western Planning Area (WPA) with the exception of the administratively deferred areas described below. The unleased area available for leasing in the WPA amounts to approximately 27.3 million acres or 5,043 blocks as of December 1985 (Figure I-1). Unleased blocks are located from approximately 9-222 miles offshore in water depths ranging from approximately 8 m to over 3,000 m. Excluded from the Call for Information and Nominations for Sale 112 are Blocks A-375 (East Flower Garden Bank) and A-398 (West Flower Garden Bank) in High Island Area, East Addition, South Extension and 123 blocks located in South Padre Island Area and South Padre Island Area, East Addition along the provisional United States maritime boundary with Mexico.

The live bottom, topographic features, archaeological resource, and military areas stipulations are being considered for adoption as mitigating measures for Sale 110. The topographic features, archaeological resource, and military areas stipulations are being considered for adoption as mitigating measures for Sale 112. The proposed actions are discussed as Alternative A in Sections II and IV of this Environmental Impact Statement (EIS). The proposed sale areas and deferrals are shown in Figure I-1. Depiction of areas under lease as of November 1985 are shown on Visual No. 1, Historic Leasing.

Basic assumptions, estimates, and development scenarios for impact analyses of the proposed actions are presented in Section IV.A. Three development scenarios for each proposed action provide a quantitative and locational framework for the impact analyses. The Most Likely Find Scenarios (M Scenario) are the focus of the impact analyses for the proposed sales and alternatives and are also used along with other impact producing factors in the cumulative analyses (Section IV.D.). Low and High Find Scenarios were also used in supplemental analyses for comparative purposes (Sections IV.D.1.d. and IV.D.2.d.). Table S-1 provides resource and offshore infrastructure estimates for each scenario.

Issues and Areas of Concern

To fulfill the Outer Continental Shelf Lands Act (OCSLA) and the Council on Environmental Quality (CEQ) requirements and regulations to involve others in OCS planning and decision making, MMS contacted and coordinated with Federal, State, and local governments, institutions, public interest groups, and individuals during the scoping period to obtain resource information, to evaluate concerns about the proposals, and to identify environmental issues and alternatives to be analyzed in the EIS. Table S-2 lists the environmental and other issues of concern chosen for analysis in this document as a result of the scoping process for Sales 110 and 112 (Section I.B.2.).

Historically, Central and Western Gulf OCS sales have offered deletion alternatives geared towards protecting the biologically sensitive areas near topographic highs. An alternative was devised which would delete some or all of these biologically sensitive areas for both Sales 110 and 112.

Table S-1

Resource and Offshore Infrastructure Estimates. Sales 110 and 112

	Central Planning Area - Sale 110 M Scenario	Western Planning Area - Sale 112 M Scenario
Acreage Available for Leasing[1] (millions of acres)	31.4	27.3
Resources Expected to be Developed		
Oil (billion bbls)	0.260	0.130
Gas (tcf)	2.150	1.870
Annual Peak Production		
Oil (billion bbls)	0.023	0.012
Gas (tcf)	0.194	0.168
Offshore Infrastructure		
Exploration and Delineation Wells	320	216
Platforms	34	23
Development Wells	408	276
Pipeline (miles)	250	250

Note: Tables IV-33 and IV-41 include estimates for the Low Find (L) and High Find (H) Scenarios. These scenarios are described and analyzed in Section IV.D.1.d. (Central Gulf Sale 110) and Section IV.D.2.d. (Western Gulf Sale 112).

[1] Unleased acreage available for leasing (deferred acreage not included) as of December 1985.

Source: USDI, Minerals Management Service, Gulf of Mexico OCS Region estimates.

Table S-2

Environmental Impact and Issues of Concern

- Sensitive Coastal Habitats
  - Barrier Beaches/Islands
  - Wetlands
- Sensitive Offshore Habitats
  - Topographic Features
  - Live Bottom Areas
- Water Quality
- Air Quality
- Endangered and Threatened Species
  - Brown Pelicans
  - Marine Mammals (Whales)
  - Sea Turtles
- Coastal and Marine Birds
- Commercial Fishing Industry
- Major Shorefront Recreational Beaches
- Archaeological Resources
  - Historic
  - Prehistoric

Alternatives for Central Gulf Sale 110 (April 1987) and Expected Impacts

The courses of action for this sale are as follows. A comparison of the alternatives is discussed in Section II.A.4.

Alternative A (The Proposed Action)

The proposed action is to offer for lease for oil and gas exploration and development all unleased areas (approximately 31.4 million acres or 5,821 blocks) within the CPA. The proposed action is expected to result in the production of 0.260 billion bbls of oil and 2.150 tcf of gas over a 22-year period, thus contributing towards the reduction of the Nation's dependence on foreign energy sources.

Table S-3 provides a summary of the impact levels on each resource category expected to result from the proposed action and the cumulative impact levels expected to result from the proposed action plus other impact producing factors. Definitions of the impact levels for each resource category are shown on Table S-4. The live bottom, topographic features, archaeological resources, and military areas stipulations are being considered for adoption as mitigating measures.

Alternative B (No Action)

This alternative equates to cancellation of the sale. Impacts and oil and gas production expected to result from the proposed action would not occur.

Alternative C (Delete Biologically Sensitive Offshore Habitats)

This alternative would delete all 67 of the unleased blocks of the 177 total blocks on or near biologically sensitive areas of the topographic features in the Central Gulf. This alternative is presented as an environmental protection measure should the stipulation not be adopted.

Alternatives for Western Gulf Sale 112 (August 1987) and Expected Impacts

The courses of action for this sale are as follows. A comparison of the alternatives is discussed in Section II.B.4.

Alternative A (The Proposed Action)

The proposed action is to offer for lease for oil and gas exploration and development all unleased areas within the WPA, with the exception of the following administratively deferred areas: Block A-375 (East Flower Garden Bank) and Block A-398 (West Flower Garden Bank) in High Island Area, East Addition, South Extension and 123 blocks located in South Padre Island Area and South Padre Island Area, East Extension along the United States provisional maritime boundary with Mexico. Approximately 27.3 million acres or 5,043 blocks will be available for lease. The proposed action is expected to result in the production of 0.130 billion bbls of oil and 1.870 tcf of gas over a 22-year period, thus contributing towards the reduction of the Nation's dependence on foreign energy sources.

Table S-3 provides a summary of the impact levels on each resource category expected to result from the proposed action and the cumulative impact levels expected to result from the proposed action plus all other impact producing factors. Definitions of the impact levels for each resource category are shown on Table S-4. The biological, archaeological resources, and military areas stipulations are being considered for adoption as mitigating measures.

Alternative B (No Action)

This alternative equates to cancellation of the sale. Impacts and oil and gas production expected to result from the proposed action would not occur.

Alternative C (Delete Biologically Sensitive Offshore Habitats)

This alternative would delete all 56 of the unleased blocks of the 200 total blocks on or near biologically sensitive areas of the topographic features in the Western Gulf. This alternative is presented as an environmental protection measure should the stipulation not be adopted.

Potential Impact Levels[1] from Alternatives A, B, and C, and the Cumulative Analyses

Resource Category	Central Gulf Sale 110 (April 1987)				Western Gulf Sale 112 (August 1987)			
	Alt. A[2]	Alt. B[3]	Alt. C[4]	Cumulative[5]	Alt. A[2]	Alt. B[3]	Alt. C[4]	Cumulative[5]
1. Sensitive Coastal Habitats								
a. Barrier Beaches/Islands	L	NE	L	VH	L	NE	L	VH
b. Wetlands	L	NE	L	VH	L	NE	L	M
2. Sensitive Offshore Habitats								
a. High Topographic Features	VH	NE	NE	VH	VH	NE	NE	VH
b. Live Bottom Areas	H	N/A	NE	H	N/A	N/A	N/A	N/A
3. Water Quality								
a. Offshore	L	NE	L	VH	L	NE	L	VH
b. Onshore	L	NE	L	VH	L	NE	L	VH
4. Air Quality	M[6]	NE	M	M	M[6]	NE	M	M
5. Endangered/Threatened Species								
a. Brown Pelicans	VL	NE	VL	M	VL	NE	VL	M
b. Marine Mammals (Whales)	VL	NE	VL	M	VL	NE	VL	M
c. Sea Turtles	L	NE	L	VH	L	NE	L	VH
6. Coastal and Marine Birds	L	NE	L	M	VL	NE	VL	M
7. Commercial Fishing Industry	M	NE	M	H	M	NE	M	H
8. Major Shorefront Recreational Beaches	L	NE	L	M	M	NE	M	VH
9. Archaeological Resources								
a. Historic	VH	NE	VH	VH	VH	NE	VH	VH
b. Prehistoric	VH	NE	VH	VH	VH	NE	VH	VH

Potential Impact Levels with Proposed Stipulations Applied

Resource Category	Central Gulf Alt. A[2]	Central Gulf Alt. B[3]	Central Gulf Alt. C[4]	Central Gulf Cumulative[5]	Western Gulf Alt. A[2]	Western Gulf Alt. B[3]	Western Gulf Alt. C[4]	Western Gulf Cumulative[5]
10. Sensitive Offshore Habitats								
a. High Topographic Features	VL	N/A	NE	VL	VL	NE	NE	VL
b. Live Bottom Areas	VL	N/A	NE	M	N/A	N/A	N/A	N/A
11. Archaeological Resources								
a. Historic	VL[7]	NE	VL[7]	VH	VL[8]	NE	VL[8]	VH
b. Prehistoric	VL	NE	VL	VH	VL	NE	VL	VH

VH - Very High
H - High
M - Moderate
L - Low
VL - Very Low
NE - No Effect
N/A - Not Applicable

[1] Definitions of impact levels are provided in Table S-4. The impact levels are the results of analyses located in Section IV.D.1.
[2] The Proposed Action.
[3] No Action.
[4] Delete Biologically Sensitive Offshore Habitats.
[5] Cumulative impacts of proposed action plus all other impact producing factors.
[6] Some of the coastal counties have very low impacts. See Section IV.D.1.a.(4) for specific county listings.
[7] The impact level listed represents subplanning areas C-1 and C-4 with the proposed stipulation. The impact level for subplanning areas C-2 and C-3 with the proposed stipulation is expected to be very high.
[8] The impact level listed represents subplanning areas W-2 and W-3 with the proposed stipulation. The impact level for subplanning area W-1 with the proposed stipulation is expected to be very high.

Table 5-4

Definitions Assumed in Impact Assessment

	Very High	High	Moderate	Low	Very Low
Sensitive Coastal Habitats	Very severe long-term adverse effects: more than 2% of the habitat area destroyed or altered; or loss/interference due to oil spill contacts with sensitive coastal habitats (4 or more).	Major long-term adverse effects: 1%-2% of the habitat area destroyed or altered; or loss/interference due to oil spill contacts with sensitive coastal habitats (2-3).	Moderate adverse effects: 0.25%-1% of the habitat area destroyed or altered; or loss/interference due to oil spill contacts with sensitive coastal habitats (1).	Minor adverse effects: 0.02%-0.25% of the habitat area destroyed or altered; no spill contacts with sensitive coastal habitats.	Negligible to minor effects: 0.02% or less of the habitat area destroyed or altered; no spill contacts with sensitive coastal habitats.
Sensitive Offshore Habitats a. High Topographic Features	A species, population, community, or assemblage will be harmed to the extent that recovery of that particular entity may not occur.	A significant interference with ecological relationships. This usually involves the mortality or a biological alteration of a noticeable segment of the population, community, or assemblage.	A short-term interference with ecological relationships. Although some species may sustain substantial losses, other species will sustain low losses, and the ecological mix will not be altered.	A few species may sustain low losses, but any interference with ecological relationships will not be evident.	Loss of a few individuals but no interference with ecological relationships.
b. Live Bottom Areas (Central Gulf only)	Substantial and permanent destruction of a large portion of the pinnacle environment and the assemblage thereon.	Mortality of the pinnacle community and destruction of the environment such that recovery is long-term (greater than one year).	Substantial damage to a localized area. Recovery may be precluded or long-term.	Short-term interference with ecological relationships. Recovery is short-term (within one year).	Localized short-term interference with ecological relationships.
Water Quality	Water quality parameters change significantly by several orders of magnitude; toxic trace metals or hydrocarbons exceed USEPA safe levels; changes persist for months or longer.	Water quality parameters change significantly one or two orders of magnitude; toxic trace metals or hydrocarbons near USEPA safe levels; changes persist for days to weeks.	Statistically significant changes in water quality parameters which persist for several weeks.	Some measures of water quality deviate significantly from ambient measures but are quickly (within 1-2 days) restored to normal.	Normal measures of water quality such as oxygen content, salinity, temperature, transmittance, trace metal concentrations, and hydrocarbon levels show no statistically significant changes from ambient conditions.
Air Quality	OCS-related offshore or onshore sources significantly increase levels of criteria pollutants such that nonattainment areas will be degraded further or attainment and PSD areas are significantly degraded.* Significant effects on public health and welfare are expected.	OCS-related offshore or onshore sources increase levels of criteria pollutants such that nonattainment areas are likely to be degraded less than significantly or attainment and PSD areas are likely to degrade.* Likely to pose hazards to public health and welfare.	OCS-related offshore or onshore sources increase levels of criteria pollutants such that nonattainment areas are unlikely to experience minor degradation and attainment and PSD areas are not likely to degrade significantly.* Unlikely to pose hazards to public health and welfare.	OCS-related offshore or onshore sources increase levels of criteria pollutants such that nonattainment areas are unlikely to be degraded further and attainment and PSD areas are likely to undergo only very small increases in levels of criteria pollutants.* Very unlikely to pose hazards to public health and welfare.	OCS-related offshore or onshore sources increase levels of criteria pollutants such that nonattainment areas will not be degraded further and attainment and PSD areas are likely to undergo negligible increases in levels of criteria pollutants.* Does not pose any hazard to public health and welfare.

Table S-4 Definitions Assumed in Impact Assessment (continued)

	Very High	High	Moderate	Low	Very Low
Endangered and Threatened Species	A population declines in the affected area resulting in a change in the distribution and/or abundance (greater than 5%) of the species in the local area and/or the planning area. The expected duration of the effects within the local area and/or the planning area is more than three generations** or 10 years or more.	A population declines in the affected area resulting in a change in the distribution and/or abundance (less than or equal to 5%) of the species in the local area and/or the planning area. The expected duration of the effects within the the local area and/or the planning area is two or three generations or 6-9 years.	A population declines in the affected area resulting in a change in the distribution and/or abundance (less than or equal to 1%) of the species in the local area and/or the planning area. The expected duration of the effects within the local area and/or the planning area is one generation or 3-5 years.	A population declines in the affected area resulting in a change in the distribution and/or abundnace of the species in the local area and/or the planning area. The expected duration of the effects within the local area and/or the planning area is less than one generation or 1-3 years.	No discernible lethal effects, but individuals experience sublethal effects which cause reduced biogenic activity or reduced metabolic functions. Organisms would recover to pre-impact condition in less than one generation or 1-2 years.
Coastal and Marine Birds	A population declines in the affected area resulting in a change in the distribution and/or abundance of the species in the local area and/or the planning area. The expected duration of the effects within the local areas and/or the planning area is more than three generations** or 10 years or more.	A population declines in the affected area resulting in a change in the distribution and/or abundance of the species in the local area and/or the planning area. The expected duration of the effects within the local area and/or the planning area is two or three generations or 6-9 years	A population declines in the affected area resulting in a change in the distribution and/or abundance of the species in the local area and/or the planning area. The expected duration of the effects within the local area and/or the planning area is one generation or 3-5 years.	A population declines in the affected area resulting in a change in the distribution and/or abundance of the species in the local area and/or the planning area. The expected duration of the effects within the local area and/or the planning area is less than one generation or 1-3 years.	No discernible lethal effects which cause reduced biogenic activity or reduced metabolic functions. Organisms would recover to pre-impact condition in less than one generation or 1-2 years.
Commercial Fishing Industry	An economic loss of greater than 5% to the commercial fishing industry, many fishermen out of work, and secondary employment (processing plants, etc.) substantially affected.	A 1%-5% economic loss to the commercial fishing industry, some fishermen out of work, and secondary employment affected.	A 0.01%-0.1% economic loss to the commercial fishing industry, some financial loss to fishermen, and secondary employment affected	A 0.01%-0.1% economic loss to the commercial fishing industry, some fishermen affected, but no effect on secondary employment.	A 0.01% or less economic loss to the commercial fishing industry, and a few fishermen affected
Major Shorefront Recreational Beaches	The overall quantity of major recreational beaches in the region will permanently change and/or a persistent change in the quality of a majority of the major beaches will be evident. Sustained regional influence on the beaches or beach-related recreational activities is expected to cause beach administrative and maintenance costs to increase significantly throughout the region. A long-term decline in regional tourism is likely to result.	The quality of a small percentage (those associated with at least one community) of major recreational beaches in the region will be permanently affected. Sustained influence (one or more years) on the type and intensity of beach-related recreational activities is expected to influence regional and subregional displacement of recreational use. Sustained pollution or contamination of beaches causes persistent and significant increases in beach maintenance and administrative costs on a subragional basis. A long-term decline in tourism in portions of the planning area is likely.	The quality of a large percentage (more than one community or political subdivision) of the major recreational beach environment is minimal yat perceivably affected in a sustained manner, yet the level and type of recreational activity is not changed. Acute, short-term damage to individual beaches can occur. Beach administrative and maintenance costs will increase significantly on a short-term basis (less than one year) subregionally. Short-term effects on tourism at specific beach parks is expected.	The quantity or quality of the major recreational beach environment does not change in a perceptible or sustained manner either regionally or subregionally, acute, short-term damage to individual recreational beaches is slight; the influence on one or more beach-related recreational activities is not major, and increases in beach administrative and maintenance costs are short-term and localized. Tourism implications are nil.	The quantity or quality of major recreational beaches does not change, short-term damage to individual recreational beaches is negligible. Impacts do not preclude recreational use although they may cause minor inconveniences to local users or site administrators. Beach administrative and maintenance costs are unaffected from the base case. No effect is expected on tourism.

Table S-4. Definitions Assumed in Impact Assessment (continued)

	Very High	High	Moderate	Low	Very Low
Archaeological Resources	An interaction between an archaeological site and an impact producing factor occurs and results in the loss of unique archaeological information.	An interaction between an archaeological site and an impact producing factor occurs and results in the loss of significant,*** but not unique, archaeological information	An interaction between an archaeological site and an impact producing factor occurs and results in the loss of archaeological data that are not significant ***	An interaction between an archaeological site and an impact producing factor occurs, but impacts are temporary and reversible.	Little damaging interaction between an impact producing factor and an archaeological site occurs

*Note that levels of degradation of PSD areas are rleative to whether they are a Class I, Class II, or Class III area, i.e., very small changes in pollutant levels are considered significant for Class I areas. (Refer to Tables IV-39, IV-40, and IV-41 of the Final Regional EIS for significance levels relative to the above definition and PSD areas.)

**A generation is the term of years accepted as the average period between the birth of the parents and the birth of the offspring.

***Significance as per National Register criteria

CONTENTS

Page

SUMMARY v

TABLES xxi

FIGURES xxv

ABBREVIATIONS AND ACRONYMS xxix

I. PURPOSE AND BACKGROUND OF THE PROPOSED ACTIONS 3

A. PURPOSE AND NEED 3

B. BACKGROUND OF THE PROPOSED ACTIONS 5

1. Administrative Events Leading to the Proposed Actions 5

2. Scoping Activities and Findings 5
   - a. Alternatives 5
     - (1) Alternatives Considered for Central Gulf Sale 110 5
     - (2) Alternatives Considered for Western Gulf Sale 112 5
     - (3) Alternatives Not Included in the EIS 6
   - b. Proposed Mitigating Measures Included in the EIS 6
   - c. Issues 6
     - (1) Issues Analyzed in the EIS 6
     - (2) Issues Not Analyzed in the EIS 8

3. Regulatory and Administrative Framework - Department of the Interior 13
   - a. Presale Activity 13
     - (1) Federal/State Coordination 13
     - (2) Geological and Geophysical Activity Regulations/Coordination 14
   - b. Postsale Activity Regulation/Coordination 14
     - (1) Review, Coordination, and Approval of Exploration, Development, and Production Activities 15
       - (a) Exploration Plans 15
       - (b) Development and Production Plans 16
       - (c) Environmental Reports/Information 19
       - (d) Pipelines 19
       - (e) Application for Permit to Drill 19
       - (f) Platform Verification Program 20
     - (2) Regulatory Enforcement Measures 20
       - (a) Inspections 20
       - (b) Special Inspection Procedures 20
       - (c) Suspension of Operations and Cancellation of Leases 21
       - (d) Remedies and Penalties 21
     - (3) Environmental Safeguards 21
       - (a) OCS Orders 21
       - (b) Lease Stipulations 21
       - (c) Air Quality 22
       - (d) Best Available and Safest Technology 22
       - (e) Pipelines 22
       - (f) Other Environmental Safety Controls 23
     - (4) Regional Technical Working Group 23

4. Other Federal Agency Regulatory/Administrative Measures 24
  a. Navigation 24
  b. OCS Pipelines 24
  c. Coastal Zone Management 24
  d. Archaeological Resources Legislation 25
  e. Endangered Species Act of 1973 25
  f. Marine Mammal Protection Act of 1972 25
  g. Fishery Conservation and Management Act of 1976 26
  h. Maritime Boundary 26
  i. National Fishing Enhancement Act of 1984 26
  j. Executive Order 11990, Protection of Wetlands 26
  k. Ports and Waterways Safety Act 27

5. Regulations Governing Oil Spills, Petroleum Effluents, and Other Discharges 27

6. Interrelationship with Other Programs and Proposals 31
  a. Estuarine and Marine Sanctuaries 31
  b. Deepwater Ports 32
  c. Ocean Thermal Energy Conversion 32
  d. Offshore Mining 32
  e. Ocean Dumping 33
  f. Ocean Incineration 33
  g. Dredge Material 35
  h. National Defense 35
  i. OCS Geothermal 35
  j. Strategic Petroleum Reserve 36

7. Gulf of Mexico Regional Environmental Studies Program 36

II. ALTERNATIVES INCLUDING THE PROPOSED ACTIONS 39

A. CENTRAL GULF SALE 110 39

1. Alternative A - The Proposed Action 39
  a. Description of the Proposed Action 39
  b. Summary of Impacts 41
    (1) Impacts on Sensitive Coastal Habitats 41
      (a) Barrier Beaches/Islands 41
      (b) Wetlands 42
    (2) Impacts on Sensitive Offshore Habitats 42
    (3) Impacts on Water Quality 42
      (a) Offshore 42
      (b) Onshore 43
    (4) Impacts on Air Quality 43
    (5) Impacts on Endangered and Threatened Species 43
      (a) Brown Pelicans 43
      (b) Marine Mammals (Whales) 43
      (c) Sea Turtles 44
    (6) Impacts on Coastal and Marine Birds 44
    (7) Impacts on the Commercial Fishing Industry 44
    (8) Impacts on Major Shorefront Recreational Beaches 44

            (9) Impacts on Archaeological Resources 44
                (a) Historic 44
                (b) Prehistoric 45

        c. Proposed Mitigating Measures 45
            (1) Topographic Features Stipulation 45
            (2) Live Bottom Stipulation 47
            (3) Archaeological Resource Stipulation 48
            (4) Military Areas Stipulation 51

        d. Notice to Lessees and Operators (NTL) 83-3 Concerning Shallow Hazards for the Gulf of Mexico OCS Region 53

    2. Alternative B - No Action 54
        a. Description of the Alternative 54
        b. Summary of Impacts 54

    3. Alternative C - Delete Biologically Sensitive Offshore Habitats 54
        a. Description of the Alternative 55
        b. Summary of Impacts 55

    4. Comparison of Alternatives 55

B. WESTERN GULF SALE 112 55

    1. Alternative A - The Proposed Action 55
        a. Description of the Proposed Action 55
        b. Summary of Impacts 58
            (1) Impacts on Sensitive Coastal Habitats 58
                (a) Barrier Beaches/Islands 58
                (b) Wetlands 58
            (2) Impacts on Sensitive Offshore Habitats 59
            (3) Impacts on Water Quality 59
                (a) Offshore 59
                (b) Onshore 59
            (4) Impacts on Air Quality 59
            (5) Impacts on Endangered and Threatened Species 60
                (a) Brown Pelicans 60
                (b) Marine Mammals (Whales) 60
                (c) Sea Turtles 60
            (6) Impacts on Coastal and Marine Birds 60
            (7) Impacts on the Commercial Fishing Industry 60
            (8) Impacts on Major Shorefront Recreational Beaches 61
            (9) Impacts on Archaeological Resources 61
                (a) Historic 61
                (b) Prehistoric 61
        c. Proposed Mitigating Measures 61
            (1) Topographic Features Stipulation 61
            (2) Archaeological Resource Stipulation 64
            (3) Military Areas Stipulation 64
        d. Notice to Lessees and Operators (NTL) 83-3 Concerning Shallow Hazards for the Gulf of Mexico OCS Region 64
        e. Proposed Information to Lessees on the Gulf Ocean Incineration Site 65

2. Alternative B - No Action 65
  - a. Description of the Alternative 65
  - b. Summary of Impacts 65

3. Alternative C - Delete Biologically Sensitive Offshore Habitats 66
  - a. Description of the Alternative 66
  - b. Summary of Impacts 66

4. Comparison of Alternatives 66

III. DESCRIPTION OF THE AFFECTED ENVIRONMENT 69

A. PHYSICAL ELEMENTS OF THE ENVIRONMENT 69

1. Environmental Geology and Hazards 69
  - a. Geology 69
  - b. Geologic Hazards 69
  - c. Non-Oil and Non-Gas Mineral Resources 70

2. Meteorological Conditions 70

3. Physical Oceanography 72

4. Chemical Oceanography 74

5. Water Quality 80

6. Air Quality 83

B. BIOLOGICAL RESOURCES 83

1. Coastal Habitats 83
  - a. Barrier Beaches/Islands 85
  - b. Wetlands 88

2. Offshore Habitats 89

3. Endangered and Threatened Species 97

4. Other Wildlife Species 98
  - a. Marine Mammals 98
  - b. Coastal and Marine Birds 98

5. Commercial Fisheries 98

C. SOCIOECONOMIC CONDITIONS 100

1. Employment 101

2. Income 102

3. Population 105

4. Coastal Management Programs 105

5. Oil and Gas Industry 109

6. Ports and Marine Transportation 115

7. Military Use/Warning Areas 115

8. Commercial Fishing Industry 117

9. Recreational Activities 119

10. Archaeological Resources 119
 a. Historic 120
 b. Prehistoric 124

11. Water Supply 127

IV. ENVIRONMENTAL CONSEQUENCES 135

A. DEVELOPMENT SCENARIOS 135

1. Proposed Actions: Most Likely Find Scenarios (M Scenarios) 135
 a. Resource and Offshore Infrastructure Estimates 135
 b. Development Timetables 138
 c. Transportation Assumptions 138
 d. Onshore Facility Use Estimates 140

2. Cumulative Activities (Cumulative Scenarios for the Proposed Actions) 140
 a. Cumulative Scenario Factors Related to the Proposed Actions and to Prior and Future OCS Lease Sales 143
 b. State Offshore Oil/Gas Activities 148
 c. Other Major Offshore Activities 149
 d. Major Onshore Activities in Coastal Areas 153
 e. Natural Events and Processes 155

3. Low and High Find Scenarios 155

4. Impact Producing Factors Related to Routine Offshore and Onshore Support Activities 155
 a. Effluent Discharges 155
 b. Air Emissions 165
 c. Noise Emissions 166
 d. Physical Presence of Drilling Rigs, Platforms, Boats, and Barges 168
 e. Pipeline Construction 169
 f. Dredging Activities 171
 g. Seismic Operations 171
 h. Trash and Debris 172
 i. Anchoring 172

B. OIL SPILLS 172

1. Historic Spill Rates 172

2. Estimated Mean Number of Spills 174

3. Trajectory Simulation 175

4. Estimated Number of Oil Spills Occurring and Contacting Sensitive Resources 179

5. Chronic or Long-term Oil Pollution 179
  a. Sources of Hydrocarbon Inputs into the Gulf of Mexico 179
  b. Sublethal and Long-term Effects of Chronic or Low-level Oil Pollution 179

6. Assumptions about the Characteristics, Fates, and Effects of a Typical Oil Spill Occurring from OCS Oil Development Activities 186
  a. Characteristics 186
  b. Fates 186
  c. Effects of Oil Spillage 189
  d. Factors Affecting the Severity of Oil Spill Impact 191

7. Effects of Catastrophic Oil Spills 195

8. Oil Spill Containment/Cleanup Capabilities and Effectiveness 201
  a. Equipment Locations 202
  b. Equipment Effectiveness 202
  c. Recent Important Accidents 205

C. ITEMS OF SPECIAL CONCERN 208

1. Hazardous Conditions 208

2. Ordnance Disposal 209

3. Blowouts 209

D. ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTIONS AND ALTERNATIVES 210

1. Central Gulf Sale 110 210
  a. Impacts from Alternative A - The Proposed Action 210
    (1) Impacts on Sensitive Coastal Habitats 210
      (a) Barrier Beaches/Islands 212
      (b) Wetlands 215
    (2) Impacts on Sensitive Offshore Habitats 219
      (a) Topographic Features 219
      (b) Live Bottoms 228
    (3) Impacts on Water Quality 231
      (a) Offshore 232
      (b) Onshore 237
    (4) Impacts on Air Quality 240
    (5) Impacts on Endangered and Threatened Species 245
      (a) Brown Pelicans 246
      (b) Marine Mammals (Whales) 247
      (c) Sea Turtles 248

(6) Impacts on Coastal and Marine Birds 250
(7) Impacts on the Commercial Fishing Industry 252
(8) Impacts on Major Shorefront Recreational Beaches 256
(9) Impacts on Archaeological Resources 259
(a) Historic 259
(b) Prehistoric 262
b. Impacts from Alternative B - No Action 264
c. Impacts from Alternative C - Delete Biologically Sensitive Offshore Habitats 266
d. Low and High Find Scenario Analyses: Proposed Action 266
e. Unavoidable Adverse Impacts of the Proposed Action 278
f. Irreversible and Irretrievable Commitment of Resources 279
g. Relationship Between the Short-term Use of Man's Environment and the Maintenance and Enhancement of Long-term Productivity 280

2. Western Gulf Sale 112 281
a. Impacts from Alternative A - The Proposed Action 281
(1) Impacts on Sensitive Coastal Habitats 281
(a) Barrier Beaches/Islands 281
(b) Wetlands 281
(2) Impacts on Sensitive Offshore Habitats 285
(a) Topographic Features 285
(3) Impacts on Water Quality 295
(a) Offshore 295
(b) Onshore 299
(4) Impacts on Air Quality 300
(5) Impacts on Endangered and Threatened Species 304
(a) Brown Pelicans 305
(b) Marine Mammals (Whales) 306
(c) Sea Turtles 307
(6) Impacts on Coastal and Marine Birds 309
(7) Impacts on the Commercial Fishing Industry 310
(8) Impacts on Major Shorefront Recreational Beaches 313
(9) Impacts on Archaeological Resources 314
(a) Historic 314
(b) Prehistoric 316
b. Impacts from Alternative B - No Action 318
c. Impacts from Alternative C - Delete Biologically Sensitive Offshore Habitats 319
d. Low and High Find Scenarios Analyses: Proposed Action 319
e. Unavoidable Adverse Impacts of the Proposed Action 330
f. Irreversible and Irretrievable Commitment of Resources 332
g. Relationship Between the Short-term Use of Man's Environment and the Maintenance and Enhancement of Long-term Productivity 333

V. CONSULTATION AND COORDINATION 337

A. DEVELOPMENT OF THE PROPOSED ACTIONS 337

B. DEVELOPMENT OF THE DRAFT EIS 337

C. DISTRIBUTION OF THE DRAFT EIS FOR REVIEW AND COMMENT 343

VI. BIBLIOGRAPHY AND SPECIAL REFERENCES 351

VII. PREPARERS (TEXT AND VISUALS) 377

VIII. GLOSSARY 381

IX. APPENDICES 391

A. BLOCKS AFFECTED BY THE BIOLOGICAL STIPULATIONS IN THE CENTRAL AND WESTERN GULF OF MEXICO A-1

B. NTL 83-3 B-1

C. BIOLOGICAL OPINIONS C-1

D. SYNOPSIS OF IMPACTS FROM THE 1985 GULF OF MEXICO HURRICANES D-1

E. INVESTIGATION OF WETLANDS LOSS IN LOUISIANA COASTAL REGION: A PILOT STUDY E-1

F. DEEPWATER TECHNOLOGY F-1

G. OCEANOGRAPHY FIGURES REFERENCED IN SECTION III G-1

H. COMPARISON OF PIPELINE AND TANKER TRANSPORTATION SYSTEM OPTIONS FOR DEEPWATER AREAS IN THE GULF OF MEXICO H-1

I. ALTERNATIVE ENERGY SOURCES AS AN ALTERNATIVE TO THE LEASE SALE I-1

J. KEYWORD INDEX J-1

TABLES

Page

Table S-1 Resource and Offshore Infrastructure Estimates: Sales 110 and 112 vi
Table S-2 Environmental Impact and Issues of Concern vii
Table S-3 Potential Impact Levels from Alternatives A and B and the Cumulative Analyses ix
Table S-4 Definitions Assumed in Impact Assessment x
Table II-1 Proposed Action - Central Gulf Sale 110/Summary: Major Elements of the M Scenario and Related Impact Producing Factors 40
Table II-2 Warning Areas' Command Headquarters 52
Table II-3 Proposed Action - Western Gulf Sale 112/Summary: Major Elements of the M Scenario and Related Impact Producing Factors 57
Table III-1 Water Property Extremes in the Gulf of Mexico 76
Table III-2 Range of General Water Quality Values for Offshore Freeport, Texas, and West Louisiana Coastal Waters 81
Table III-3 Habitat Acreage for the Central and Western Analysis Areas 85
Table III-4 Biotic Zones of Topographic Features with Bank Crest and Seafloor Depth in Meters 94
Table III-5 Marine Mammals of the Northern Gulf of Mexico 99
Table III-6 Labor Force Data (Gulf of Mexico Region) 103
Table III-7 Employment by Major Industry Group/Central Gulf of Mexico - 1983 Percent of Total 103
Table III-8 Employment by Major Industry Group/Western Gulf of Mexico - 1983 Percent Total 104
Table III-9 Income Data (Gulf of Mexico Region) 104
Table III-10 Population Data (Gulf of Mexico Region 106
Table III-11 Net Migration Data (Gulf of Mexico Region) 106
Table III-12 Employment and Payroll Data/Selected Oil and Gas SIC Codes (Gulf of Mexico Region) (1983) 114
Table III-13 Import-Export Data (from vessels)/Gulf of Mexico Region (1983) 114
Table III-14 1983 Central and Western Gulf of Mexico Freight and Vessel Traffic 116
Table III-15 Catch by National Marine Fisheries Service Grid Zone 118
Table III-16 Catch by MMS Analysis Area (million pounds and million dollars) 118
Table III-17 Known Shipwrecks and Reported Losses in the Gulf of Mexico 121
Table III-18 Shipwrecks With Known Locations in the Central Gulf 122
Table III-19 Shipwrecks With Known Locations in the Western Gulf 125
Table III-20 Major Service Base Locations 129
Table III-21 Estimated Freshwater Withdrawals and Potential Water Use in Gas Processing and Refining Activities within the Gulf Coastal Counties/Parishes 130
Table IV-1 Summary - Major Elements of the M Scenario and Related Impact Producing Factors for the Proposed Action 137
Table IV-2 Estimated Development Timetable for Offshore Infrastructure: Central Gulf Sale 110 139
Table IV-3 Estimated Development Timetable for Offshore Infrastructure: Western Gulf Sale 112 139
Table IV-4 Onshore Facility Use Assumptions: Central Gulf Sale 110 141
Table IV-5 Onshore Facility Use Assumptions: Western Gulf Sale 112 142
Table IV-6 Cumulative Scenario: Summary of Major Elements 144
Table IV-7 Cumulative Scenario: Onshore Facility Use Estimates for the Proposed Action (Sale 110) and Prior and Future Sales in the Central Gulf Planning Area 146
Table IV-8 Cumulative Scenario: Onshore Facility Use Estimates for the Proposed Action (Sale 112) and Prior and Future Sales in the Western Gulf Planning Area 147
Table IV-9 Potential Impact Producing Factors with Projected Crude Oil Imports Offloaded at Gulf of Mexico Ports During the 28-Year Period of 1987-2014 150
Table IV-10 Typical Raw Combined Sanitary and Domestic Wastes from Offshore Facilities 156
Table IV-11 Gulf of Mexico Produced Water Composition - Major Constituents 160
Table IV-12 Gulf of Mexico Produced Water Composition - Trace Constituents 161

Table IV-13 Radium Content of Some Gulf Coast Oil Field Production Brines 163
Table IV-14 Typical Emissions for Exploratory Drilling Activity in the Gulf of Mexico (tons) 167
Table IV-15 Typical Emissions for a Major Platform in the Gulf of Mexico (tons/year) 167
Table IV-16 Number and Volume of Oil Spills (1964-1981) in the Gulf of Mexico Outer Continental Shelf 173
Table IV-17 Oil Spill Probability Estimates for Spills Greater than 1,000 Barrels Resulting over the Expected Production Life of Future OCS Lease Sales; from Existing Federal Leases; and from Transportating Crude Oil Imports by Tanker in the Study Area 176
Table IV-18 Trajectory Simulation Probabilities (expressed as percent chance) that an Oil Spill Starting at a Particular Location will Contact a Certain Land Area within 10 Days 177
Table IV-19 Oil Spill Risk Analysis, Central Gulf: Estimates of Oil Spills (1,000 bbls or greater) Occurring and Contacting Land Segments and Targets within 10 Days 180
Table IV-20 Oil Spill Risk Analysis, Western Gulf: Estimates of Oil Spills (1,000 bbls or greater) Occurring and Contacting Land Segments and Targets within 10 Days 182
Table IV-21 LC$_{50}$ Values for Some Gulf of Mexico Marine Animals 193
Table IV-22 Exposed Sensitive Resources in Selected Catastrophic Spill Targets 196
Table IV-23 Lafourche Parish Landings for 1983 199
Table IV-24 Galveston County Landings for 1982 201
Table IV-25 Availability of Oil Spill Cleanup Equipment 203
Table IV-26 Blowouts in the Gulf of Mexico, 1979-1984 211
Table IV-27 M Scenario Estimates of Effluent Discharges Due to Increased OCS Activities as a Result of Central Gulf Sale 110 233
Table IV-28 Air Emissions for Peak Years under M Scenario Assumption/Central Planning Area (tons/year) 242
Table IV-29 Summary of Expected Impacts on Air Quality-Proposed Action/Central Planning Area 243
Table IV-30 Twenty Year Cumulative Estimated Offshore Air Emissions/Central Planning Area (1,000 tons) 244
Table IV-31 Commercial Fisheries Resources and Impact Producing Factors/Central Gulf of Mexico 254
Table IV-32 Replacement Energy Needs/Central and Western Planning Areas 265
Table IV-33 Resource and Offshore Infrastructure Assumptions: Central Gulf Sale 110 - Low and High Find Scenarios 268
Table IV-34 Estimated Development Timetable for Offshore Infrastructure: Central Gulf Sale 110 - Low and High Find Scenarios 269
Table IV-35 Onshore Facility Use Assumptions: Central Gulf Sale 110 - Low and High Find Scenarios 270
Table IV-36 M Scenario Estimates of Effluent Discharges Due to Increased OCS Activities as a Result of Western Gulf Sale 112 296
Table IV-37 Air Emissions for Peak Years under M Scenario Assumption/Western Planning Area 301
Table IV-38 Summary of Expected Impacts on Air Quality-Proposed Action/Western Planning Area 303
Table IV-39 Twenty Year Cumulative Estimated Offshore Air Emissions/Western Planning Area 304
Table IV-40 Commercial Fisheries Resources and Impact Producing Factors/Western Gulf of Mexico 311
Table IV-41 Resource and Offshore Infrastructure Assumptions: Western Gulf Sale 112 - Low and High Find Scenarios 320
Table IV-42 Estimated Development Timetable for Offshore Infrastructure: Western Gulf Sale 112 - Low and High Find Scenarios 321
Table IV-43 Onshore Facility Use Assumptions: Western Gulf Sale 112 - Low and High Find Scenarios 323
Table D-1 Pipeline Damages from Hurricane Juan in 1985/October 30 through November 2, 1985 D-13
Table D-2 Spills from 1985 Hurricanes D-15
Table D-3 Damage to Production Platforms from Hurricanes Juan, Elena, and Danny D-16
Table D-4 Reported Vessel Casualties in the Gulf of Mexico Attributable to Hurricanes D-17

Table E-1 Louisiana Coastal Land Loss Comparison Chart E-10
Table E-2 Key to Habitat Labeling System (U.S. Fish and Wildlife Service) E-12
Table E-3 Area Summaries for Dixon Bay, NW 1/4 for Years 1956, 1978, and 1983 E-18
Table E-4 Area Summaries for Pass A Loutre, NW 1/4 for Years 1956 and 1978 E-24
Table E-5 Area Summaries for Barataria, SW 1/4 for Years 1956 and 1978 E-30
Table E-6 Area Summaries for Three Bayou Bay, NE 1/4 for Years 1956 and 1978 E-34
Table E-7 Area Summaries for Five Lakes, SE 1/4 for Years 1956 and 1978 E-42
Table F-1 Comparison of Ship and Semi-submersible Drilling Units F-6
Table H-1 Comparison of Tanker and Pipeline Transportation of Oil from Hypothetical Production Site: Estimated Impact Producing Factors and Events H-7
Table I-1 Projected U.S. Energy Production and Consumption by Type/1985-2020/Low Oil Price Scenario I-5
Table I-2 U.S. Production of Energy by Type/1970-1980 I-17
Table I-3 U.S. Consumption by Energy by Type/1970-1980 I-18
Table I-4 U.S. Net Imports by Energy Type/1970-1980 I-19
Table I-5 Prices of Domestically Produced Fossil Fuels (cents[1] per million BTU's) I-16

FIGURES

		Page
Figure I-1	Central Gulf Sale 110 and Western Gulf Sale 112 Planning Areas	4
Figure I-2	Ocean Incineration Site	12
Figure I-3	East Flower Garden Bank showing "No Activity Zone," "1 Mile Zone," and "4 Mile Zone." East Flower Garden Bank is in the High Island, East Addition, South Extension, Lease Area	17
Figure I-4	West Flower Garden Bank showing "No Activity Zone," "1 Mile Zone," and "4 Mile Zone." West Flower Garden Bank is in the High Island, East Addition, South Extension, Lease Area	18
Figure I-5	Military Warning Areas, Eglin Water Test Areas, and Explosives Dumping Areas	34
Figure II-1	Archaeological Probability Zones	50
Figure III-1	Areas of Concern with Respect to Point and Nonpoint Source Pollution within the Central and Western Gulf of Mexico	82
Figure III-2	Location of Topographic Features	93
Figure III-3	Mobile Rig Utilization Index/Gulf of Mexico/1974-1985	110
Figure III-4	Leased OCS Acreage/Producing and Non-Producing/1974-1985	111
Figure III-5	Hydrocarbon Wellhead Prices/Crude Oil and Natural Gas/1974-1985	112
Figure III-6	Curve of Relative Land-Sea Level	128
Figure IV-1	Planning Areas and Subareas	136
Figure IV-2	Crude Oil Tanker Routes to Major U.S. Ports of Entry on the Gulf of Mexico	151
Figure IV-3	Sources of Petroleum Inputs into the Gulf of Mexico Outer Continental Shelf Waters (annual percentage)	184
Figure IV-4	Blocks Leased in Proximity to Topographic Features/Central Gulf of Mexico	227
Figure IV-5	Blocks Leased in Proximity to Topographic Features/Western Gulf of Mexico	294
Figure D-1	1985 Huricanes: Danny, Elena, Juan, and Kate	D-4
Figure D-2	1985 Hurricanes: Elena, Juan, Kate, and Bob	D-5
Figure D-3	Gulf of Mexico Hurricanes 1980-1985	D-6
Figure D-4	Cumulative beach erosion due to 1985 hurricanes at Grand Isle, Louisiana	D-8
Figure D-5	Summary of the 1985 hurricane impact in coastal Louisiana as a result of Hurricanes Danny, Elena, and Juan	D-9
Figure D-6	Louisiana Shoreline and Barrier Island Restoration Costs	D-11
Figure E-1	Natural fresh marsh and bird rookery in south Louisiana	E-5
Figure E-2	Wetlands Profile - Between the Years 1956-1978 (Louisiana)	E-6
Figure E-3	Illustrates effects of saltwater intrusion on bald cypress stand	E-7
Figure E-4	Louisiana Wetlands Quadrant Ranking (Annual Percent Loss)	E-9
Figure E-5	Field Trip Itinerary	E-13
Figure E-6	Louisiana coastline in 50 years at present land loss rates[2]. Taken from 1984 Report entitled "The Louisiana Water Resources Study" Louisiana Department of Transportation	E-14
Figure E-7	Mapping of 1956 and 1978 Habitat Data for Site 1	E-19
Figure E-8	Mapping of 1983 Habitat Data for Site 1	E-20
Figure E-9	Dixon Bay, NW $^{1}/4$ sample area (Site 1)	E-21
Figure E-10	Mapping of 1956 and 1978 Habitat Data for Site 2	E-25
Figure E-11	Pass a Loutre, West, NW $^{1}/4$ sample area (Site 2)	E-26
Figure E-12	Rouseau cane stands within the Delta National Wildlife Refuge area (Site 2-lacustrine emergent marsh and open water)	E-27
Figure E-13	Levee break (Octave Pass Area) illustrating marsh building within the modern delta	E-28
Figure E-14	Mapping of 1956 and 1978 Habitat Data for Site 3	E-31
Figure E-15	Oil and gas access/dead-end canals within the Barataria, SW $^{1}/4$ sample area (Site 3)	E-15
Figure E-16	Mapping of 1956 and 1978 Habitat Data for Site 4	E-35
Figure E-17	Aerial view of the Three Bayou Bay, NE $^{1}/4$ sample area (Site 4)	E-36
Figure E-18	Marsh deterioration around dead-end canal within Three Bayou Bay site area	E-37
Figure E-19	Illustration of canal density and levee deterioration within Site 4 area	E-38

Figure E-20	Aerial view of the Barataria Waterway within the Site 4 area. Illustrates erosional/edge effect along this waterway due to vessel traffic and other factors	E-39
Figure E-21	Mapping of 1956 and 1978 Habitat Data for Site 5	E-43
Figure E-22	Right half of the photograph shows a portion of the freshwater impoundment area managed by USFWS in Five Lakes, SE 1/4 area (Site 5)	E-44
Figure E-23	Mapping of 1956 and 1978 Habitat Data for Site 6	E-46
Figure E-24	Marshy region representative of the West of Johnson's Bayou area (Site 6)	E-47
Figure F-1	Simple Pneumatic Compensator System	F-7
Figure F-2	Systems for Dynamic Positioning	F-9
Figure F-3	Taut-wire Schematic	F-10
Figure F-4	Marine Riser Assembly	F-12
Figure F-5	Simplified Subsea Blowout Preventer (BOP)	F-13
Figure F-6	Wet Subsea Completion	F-16
Figure F-7	Dry Subsea Completion	F-17
Figure F-8	Cognac Platform, Offshore Louisiana	F-19
Figure F-9	Design, Fabrication, and Installation Cost Versus Water Depth	F-20
Figure F-10	Guyed Tower	F-21
Figure F-11	Tension-Leg Platform	F-21
Figure F-12	Free-Standing Riser	F-24
Figure F-13	Exxon Articulated Riser	F-25
Figure F-14	Industry Pipeline Capability Projection	F-26
Figure F-15	Conventional Pipelaying	F-27
Figure F-16	Vertically-laid Pipeline in Deepwater	F-29
Figure G-1	Circulation Stages E1/W4. NORDA/Jaycor model simulation of surface currents for model day 3978 and wind day 1967:359 from a 10-year simulation (Wallcraft, 1985)	G-3
Figure G-2	Circulation Stages E2/W5. NORDA/Jaycor model simulation of surface currents for model day 4128 and wind day 1968:144 from a 10-year simulation (Wallcraft, 1985)	G-3
Figure G-3	Circulation Stages E3/W6. NORDA/Jaycor model simulation of surface currents for model day 4218 and wind day 1968:234 from a 10-year simulation (Wallcraft, 1985)	G-4
Figure G-4	Mean geostrophic surface currents (m/sec) from a 3-year simulation with the NORDA/Jaycor circulation model (Wallcraft, 1985). The vectors serve to illustrate the significance of surface topographic contours from the three previous figures, due to their general similarity, i.e., clockwise circulation about topographic highs and vice versa (northern hemisphere). No great significance should be given to this and other published long-term mean geostrophic current representations of the Gulf of Mexico due to the dynamic nature of its circulation	G-4
Figure G-5	Composite of eddy paths, indicating initial and final locations for eddies, studied by Elliot using hydrographic data from 1965-1972 (Elliott, 1982) (triangles) and by Brooks et al. (1984) (circles) using satellite imagery from 1980-1984	G-5
Figure G-6	Composite of all anticyclonic eddy locations identified by Vukovich (1985) in a study of 10 years of remote imagery (1974-1984). Three preferred paths were identified, indicated by the solid arrows. Bathymetry is included here to point out a possible depth limitation for these features	G-5
Figure G-7	Frequency of occurrence (%) for Loop Current water during March for the period 1973-1977, analyzed for unit 1 latitude-longitude squares based on satellite data (Vukovich et al., 1978). Of the seven months similarly analyzed (few satellite observations are useful from June to October), March displayed the apparent greatest intrusion, while November displayed the least	G-6
Figure G-8	Wave-staff analysis of the Loop Current boundary showing the mean location (solid line), northernmost and southernmost observed locations (dashed lines), and standard deviation of the mean location (dotted line) for the period May 1981-May 1982 (Auer, 1983)	G-6

Figure G-9 Revisions and extensions of two analyses previously published by Maul et al. (1978) and Vukovich et al. (1978) (upper and lower, respectively). Maul (personal communication, 1985) analyzes Loop Current penetration into the Gulf of Mexico along a line from Cape San Antonio, Cuba, to the Mississippi Delta. Vukovich (personal communication, 1985) measures northern extension by latitude and also notes specific eddy-shedding events. The graphs, approximately registered here along the time axis, reflect cycles which are neither regular nor annual. As a point of comparison, the NORDA/Jaycor model sheds 13 eddies in a 10-year simulation (Wallcraft, 1985), agreeing well with these results G-7

Figure G-10 The Loop Current boundary is frequently observed to include warm intrusions onto the shelf (shoreward of 200 m) and cold intrusions extending from the shelf seaward of 200 m. Vukovich et al. (1978) provide these analyses showing the integrated effect of all warm intrusions and cold intrusions from the months of January through May and November and December in 1973-1977. Arrows indicate the general sense of movement but are not drawn to portray specific events G-8

Figure G-11 Winter (December-February) geostrophic winds (m/sec) averaged for the period 1967-1982 (Rhodes et al., 1985) G-8

Figure G-12 Spring (March-May) geostrophic winds (m/sec) averaged for the period 1967-1982 (Rhodes et al., 1985) G-9

Figure G-13 Summer (June-August) geostrophic winds (m/sec) averaged for the period 1967-1982 (Rhodes et al., 1985) G-9

Figure G-14 Fall (September-November) geostrophic winds (m/sec) averaged for the period 1967-1982 (Rhodes et al., 1985) G-10

Figure G-15 Percentage probability that at least one tropical storm or hurricane per season will enter a unit 21/2° latitude-longtitude box (solid isopleths), modified after Hope and Newmann (1971) with some reduction in detail. Percentage probability that a tropical storm or hurricane will occur in any one year in a 50-mile segment of the coastline (circles) adopted from Simpson and Lawrence (1971). Consult the original source for precise segment locations, modified here for clarity. The lower limit for wind speeds which define a tropical storm is 34 knots G-10

Figure G-16 Hindcast 100-year expected maximum wave heights (upper envelope) and hindcast significant wave heights for selected hurricanes (lower curves), modified from Bea et al. (1983). The dashed line on the left side of each side of each graph is the breaking limit. The dashed contours on the map key represent the 100-year significant wave height, normalized by dividing the average 100-year value, over Region A and much of Region B (after Resio and Berek, 1985), indicating regional variability G-11

Figure G-17 Distribution of wind speed (upper graphs) and significant wave height (lower graphs) for the Western and Eastern Gulf of Mexico, winter and summer, from all GEOS-3 altimeter data (Parra et al., 1981) G-12

Figure G-18 Offshore Texas: Integration of several landsat imagery interpretations of a turbid coastal front (Shideler, 1979), shown here as the maximum (solid line) and minimum (dotted line) offshore penetration. Offshore Louisiana: Similar presentation for quantitative landsat interpretations by Rouse and Coleman (1976). Offshore Florida: Location of a marked "front" (solid line) in the irradiance attenuation coefficient, decreasing in the offshore direction, after Van Norden and Litts (1979). In all three areas, straight lines indicate the limits of satellite images used (Texas and Louisiana) or the limits of seasonal data available (Florida) G-13

Figure G-19 Average sea-surface temperature (°C) for the month of August (Robinson, 1973) G-13

Figure G-20 Average sea-surface temperature (°C) for the month of January (Robinson, 1973) G-14

Figure G-21 Average temperature (°C) at 150 meters for the month of January (Robinson, 1973) G-14

Figure G-22 Average temperature (°C) at 150 meters for the month of August (Robinson, 1973) G-15

Figure G-23 Annual average temperature (°C) at 1000 meters (Molinari and Festa, 1978) G-15

Figure H-1 Comparative Analysis of Tankering and Pipelining: Hypothetical Production Area, Tanker and Pipeline Routes H-4

ABBREVIATIONS AND ACRONYMS

ACAA	Alabama Coastal Area Act of 1976
ACAMP	Alabama Coastal Area Management Program
ACMI	Air Combat Maneuvering Instrumentation
ADAPTS	Air Deliverable Anti-Pollution Transfer System
AEC	Atomic Energy Commission
AEMA	Alabama Environmental Management Act
AFB	Air Force Base
AI	Area Identification
APD	Application for Permit to Drill
API	American Petroleum Institute
APR	areas for preservation and restoration
ARTC	Armament Research and Test Center
BAST	Best Available and Safest Technology
bbls	barrels
BLM	Bureau of Land Management
BOD	biological oxygen demand
BMR	Bureau of Marine Resources
B.P.	before present
CAA	Central Analysis Area
Call	Call for Information and Nominations
CCA	Central Coastal Area
CEIP	Coastal Energy Impact Program
CEQ	Council on Environmental Quality
CER	categorical exclusion review
CERCLA	Comprehensive Environmental Compensation and Liability Act
CFR	Code of Federal Regulations
CGA	Clean Gulf Associates
CMP	coastal management program
COE	Corps of Engineers
COG	Councils of Government
COPRDM	Committee on Ocean Pollution Research, Development, and Monitoring
COTP/MSO	Captain-of-the-Port/Marine Safety Office
CPA	Central Planning Area
CSA	Continental Shelf Associates
CZM	Coastal Zone Management
CZMA	Coastal Zone Management Act
DECA	Department of Economic and Community Affairs
DEM	Department of Environmental Management
DM	Departmental Manual
DMA	Defense Mapping Agency
DOC	Department of Commerce
DOCD	Development Operations Coordination Document
DOD	Department of Defense
DOE	Department of Energy
DOI (also: USDI)	Department of the Interior
DST	Deep Stratigraphic Test
EA	environmental assessment
EEZ	Exclusive Economic Zone
EFGB	East Flower Garden Bank
EIS	environmental impact statement

EPA	Eastern Planning Area
ER	Environmental Report
ERG	Energy Resources Group
ESI	environmental sensitivity index
FAA	Federal Aviation Administration
FCMA	Fishery Conservation and Management Act of 1976
F.I.R.E.	finance, insurance, and real estate
FMP	Fishery Management Plan
FR	Federal Register
FWPCA	Federal Water Pollution Control Act
FWS	Fish and Wildlife Service
FY	fiscal year
G&G	geological and geophysical
GAPC	Geographic Areas of Particular Concern
GIS	Geographic Information System
GIWW	Gulf Intracoastal Waterway
HAPC	Habitat Area of Particular Concern
IMCO	Intergovernmental Maritime Consultative Organization
IPF	impact producing factor
ITL	Information to Lessees
km	kilometer
LCRP	Louisiana Coastal Resources Program
LOOP	Louisiana Offshore Oil Port, Inc.
LUMCON	Louisiana Universities Marine Consortium
m	meter
MAFLA	Mississippi, Alabama, Florida
MCP	Mississippi Coastal Program
mi	mile
MIRG	Marine Industry Research Group
MMB	million barrels
MMS	Minerals Management Service
MODU	mobile offshore drilling unit
MOU	Memorandum of Understanding
MPRSA	Marine Protection, Research, and Sanctuaries Act of 1972
NAAQS	National Ambient Air Quality Standards
NAS	National Academy of Sciences
NASA	National Aeronautics & Space Administration
NCP	National Contingency Plan
NCSC	Naval Command System Center
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
nmi	nautical mile
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent to Prepare an EIS
NOIA	National Ocean Industries Association
NOS	National Ocean Survey
NPDES	National Pollution and Discharge Elimination System
NPS	National Park Service
NRT	National Response Team
NTL	Notice to Lessees
OAS	oil accommodated in seawater
OCD	Offshore Coastal Dispersion
OCDM	Offshore Coastal Dispersion Model
OCRM	Office of Ocean and Coastal Resource Management

OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
OEI	Offshore Ecology Investigation
ORCA	Office of Ocean Resources Coordination and Assessment
ORV	off-road vehicle
OSC	On-Scene Coordinator
OSRA	Oil Spill Risk Analysis
OTEC	Ocean Thermal Energy Conversion
OWD	oil-in-water dispersions
OWOCRS	Open Water Oil Containment and Recovery System
P.L.	Public Law
PIC	products of incomplete combustion
ppb	parts per billion
ppm	parts per million
PSD	Prevention of Significant Deterioration
RAG	Resource Appraisal Group
RCRA	Resource Conservation and Recovery Act
RD	Regional Director
RPC	Regional Planning Council
RPI	Resource Planning Institute, Inc.
RRT	Regional Response Team
RTWG	Regional Technical Working Group
SEL	Site Evaluation List
SIC	Standard Industrial Classification
SKIM	Spill Equipment Inventory System
SMA	Special Management Area
SMSA	Standard Metropolitan Statistical Area
SPRP	Strategic Petroleum Reserve Program
tcf	trillion cubic feet
TDS	total dissolved solids
TDWR	Texas Department of Water Resources
TSP	total suspended particulates
USAF	U.S. Air Force
U.S.C.	United States Code
USCG	U.S. Coast Guard
USDC	U.S. Department of Commerce
USDI (also: DOI)	U.S. Department of the Interior
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
VCAPCD	Ventura County (California) Air Pollution Control District
VOC	volatile organic compounds
WAA	Western Analysis Area
WCA	Western Coastal Area
WPA	Western Planning Area
WSF	water-soluble fractions

PURPOSE AND BACKGROUND OF THE PROPOSED ACTIONS	I
ALTERNATIVES INCLUDING THE PROPOSED ACTIONS	II
DESCRIPTION OF THE AFFECTED ENVIRONMENT	III
ENVIRONMENTAL CONSEQUENCES	IV
CONSULTATION AND COORDINATION	V
BIBLIOGRAPHY AND SPECIAL REFERENCES	VI
PREPARERS	VII
GLOSSARY	VIII
APPENDICES	IX
KEY WORD INDEX	X

I

II

III

IV

V

VI

VII

VIII

IX

X

SECTION I

PURPOSE AND BACKGROUND OF THE PROPOSED ACTIONS

I

I. PURPOSE AND BACKGROUND OF THE PROPOSED ACTIONS

A. PURPOSE AND NEED

Purpose

The purpose of the proposed actions presented in this Draft Environmental Impact Statement (EIS) is the offering for lease of Outer Continental Shelf (OCS) areas containing potential oil and gas resources in order to increase domestic production of these resources and thereby lower this Nation's dependence on foreign imports.

The proposed action for Sale 110 (April 1987) will offer for lease all unleased acreage in the Central Planning Area (CPA) which amounts to approximately 31.4 million acres or 5,821 blocks as of December 1985 (Figure I-1). Unleased blocks are located from approximately 3-220 miles offshore in water depths ranging from approximately 4 m to 3,200 m.

The proposed action for Sale 112 (August 1987) will offer for lease all unleased acreage in the Western Planning Area (WPA) with the exception of the administratively deferred areas described below. The unleased area available for leasing amounts to approximately 27.3 million acres or 5,043 blocks as of December 1985 (Figure I-1). Unleased blocks are located from approximately 9-222 miles offshore in water depths ranging from approximately 8 m to over 3,000 m. Excluded from the Call for Information and Nominations (Call) are Blocks A-375 (East Flower Garden Bank) and A-398 (West Flower Garden Bank) in High Island Area, East Addition, South Extension and 123 blocks located in South Padre Island Area and South Padre Island Area, East Addition along the provisional United States maritime boundary with Mexico.

The biological, archaeological resources, and military areas stipulations for the two planning areas are being considered for adoption as mitigating measures for both Sales 110 and 112. The proposed actions are discussed as Alternative A in Sections II and IV of this EIS. The proposed sale areas and deferrals are shown in Figure I-1. Depiction of areas under lease as of November 1985 are shown on Visual No. 1, Historic Leasing.

Basic assumptions, estimates, and development scenarios for impact analyses of the proposed actions are presented in Section IV.A. Three development scenarios for each proposed action provide a quantitative and locational framework for the impact analyses. The Most Likely Find Scenarios (M Scenario) are the focus of the impact analyses for the proposed sales, and alternatives are also used along with other impact producing factors in the cumulative analysis (Section IV.D.). Low and High Find Scenarios were also used in supplemental analyses for comparative purposes (Sections IV.D.1.d. and IV.D.2.d.). Table S-1 provides resource and offshore infrastructure estimates for the M Scenario.

Need

Current U.S. energy demands are met primarily by domestic and foreign fossil fuel. Since the Arab oil embargo of 1973-1974, it has become increasingly apparent that our Nation must become less dependent on foreign imports and lessen our vulnerability to supply interruptions. In 1978, Congress and the President mandated the Department of the Interior (DOI) to engage in "expedited exploration and development of" the OCS in order to "assure national security, reduce dependence on foreign sources, and maintain a favorable balance of payments in world trade." A discussion of the estimated amount of resources expected to be produced as a result of the proposed actions is presented in Section IV.A.

Oil and gas leasing on the OCS is administered by DOI under the auspices of the Outer Continental Shelf Lands Act (OCSLA), as amended. The Act mandates the orderly development of OCS resources. In response to this requirement, the Secretary of the Interior submits a 5-year lease schedule to the Congress, the Attorney General, and the governors of any affected state. A major objective of the OCS leasing program is to develop needed mineral resources in an environmentally acceptable manner.

This document was prepared in response to the Council on Environmental Quality's (CEQ) regulations requiring the preparation of an EIS prior to any major Federal action which could have significant effects on the environment. Frequent reference is made to the Final Regional EIS for Gulf of Mexico OCS Sales 72 (May 1983), 74 (August 1983), and 79 (January 1984) (USDI, MMS, 1983a), the Final EIS for the Central and Western Gulf of Mexico

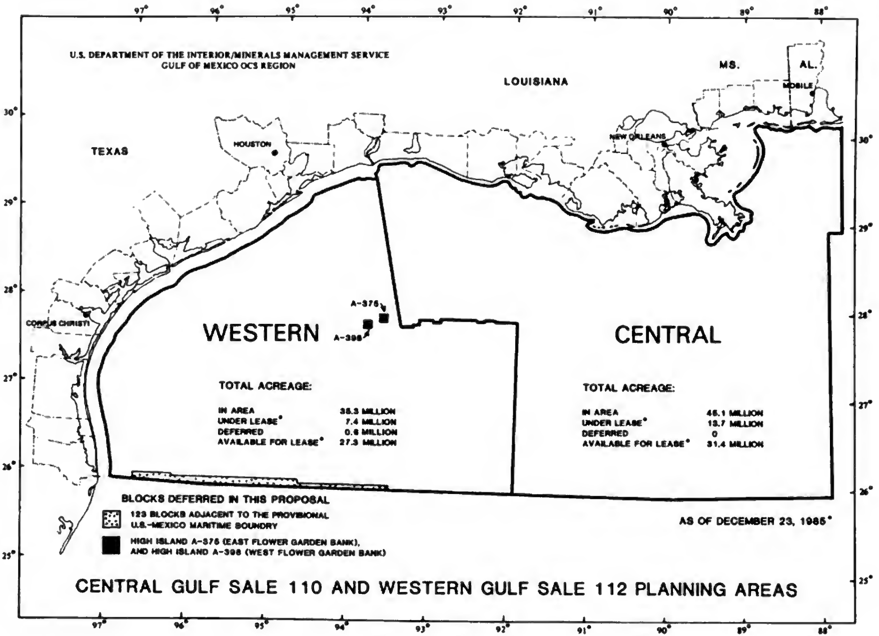

U.S. DEPARTMENT OF THE INTERIOR/MINERALS MANAGEMENT SERVICE
GULF OF MEXICO OCS REGION
TEXAS
LOUISIANA
MS.
AL.
MOBILE
HOUSTON
NEW ORLEANS
CORPUS CHRISTI
A-375
A-398
WESTERN
CENTRAL
TOTAL ACREAGE:
IN AREA 35.3 MILLION
UNDER LEASE* 7.4 MILLION
DEFERRED 0.6 MILLION
AVAILABLE FOR LEASE* 27.3 MILLION
TOTAL ACREAGE:
IN AREA 45.1 MILLION
UNDER LEASE* 13.7 MILLION
DEFERRED 0
AVAILABLE FOR LEASE* 31.4 MILLION
BLOCKS DEFERRED IN THIS PROPOSAL
123 BLOCKS ADJACENT TO THE PROVISIONAL U.S.-MEXICO MARITIME BOUNDRY
HIGH ISLAND A-375 (EAST FLOWER GARDEN BANK), AND HIGH ISLAND A-398 (WEST FLOWER GARDEN BANK)
AS OF DECEMBER 23, 1985*
CENTRAL GULF SALE 110 AND WESTERN GULF SALE 112 PLANNING AREAS
97°
96°
95°
94°
93°
92°
91°
90°
89°
88°
30°
29°
28°
27°
26°
25°

Figure I-1

Lease Offerings for 1984 [81 (April 1984) and 84 (July 1984)] (USDI, MMS, 1983b), the Final EIS for 1985 Gulf of Mexico OCS Sales 94 (November 1985), 98 (May 1985), and 102 (August 1985) (USDI, MMS, 1984a), and the recently published Final EIS for 1986 Gulf of Mexico OCS Sales 104 (April 1986) and 105 (July 1986) (USDI, MMS, 1985a).

B. BACKGROUND OF THE PROPOSED ACTIONS

1. Administrative Events Leading to the Proposed Actions

The Call for Information for the two 1987 lease sales was published in the *Federal Register* on Monday, June 24, 1985 (50 FR 26054). Requests for scoping information were sent to the public; environmental groups; Federal, State, and local government agencies; and industry at the time of the Call and Notice of Intent to Prepare an EIS (NOI). Requests for environmental/resource information were sent to Federal and State agencies on August 16, 1985.

2. Scoping Activities and Findings

Scoping is the process by which issues related to the proposed actions are identified. Leasing on the Gulf of Mexico OCS has continued for over 30 years and as a result, most of the pertinent environmental and socioeconomic issues have been known for some time. As for all previous EIS's, the Gulf of Mexico OCS Region conducted a scoping effort for this Draft EIS to further provide information for the development of appropriate alternatives to the proposed actions, mitigating measures, and to identify new issues and eliminate existing issues that may not need further treatment in the EIS. The governors of the Gulf States and nearly 500 other contacts, including State and Federal agencies, industry, environmental groups, and interested individuals, were given an opportunity to comment. A detailed description of the EIS consultation and coordination process is located in Section V.B. of this document. Following are the results of the scoping process including descriptions of alternatives, mitigating measures, and issues that were raised but not selected for analysis in this EIS.

a. Alternatives

(1) Alternatives Considered for Central Gulf Sale 110

Alternative A (The Proposed Action): The proposed action is to offer for lease for oil and gas exploration and development all unleased areas (approximately 31.4 million acres or 5,821 blocks) within the CPA. The proposed action is expected to result in the production of 0.260 billion bbls of oil and 2.150 tcf of gas.

Alternative B (No Action): This alternative equates to cancellation of the sale. Impacts and oil and gas production expected to result from the proposed action would not occur.

Alternative C (Delete Biologically Sensitive Offshore Habitats): This alternative would delete all 67 of the unleased blocks of the 177 total blocks on or near biologically sensitive areas of the topographic features in the Central Gulf. This alternative is presented as an environmental protection measure should the stipulation not be adopted.

(2) Alternatives Considered for Western Gulf Sale 112

Alternative A (The Proposed Action): The proposed action is to offer for lease for oil and gas exploration and development all unleased areas within the WPA, with the exception of the following areas excluded from the Call: Block A-375 (East Flower Garden Bank) and Block A-398 (West Flower Garden Bank) in High Island Area, East Addition, South Extension and 123 blocks located in South Padre Island Area and South Padre Island Area, East Extension along the provisional United States maritime boundary with Mexico. Approximately 27.3 million acres or 5,043 blocks will be available for lease. The proposed action is expected to result in the production of 0.130 billion bbls of oil and 1.870 tcf of gas.

Alternative B (No Action): This alternative equates to cancellation of the sale. Impacts and oil and gas production expected to result from the proposed action would not occur.

Alternative C (Delete Biologically Sensitive Offshore Habitats): This alternative would delete all 56 of the unleased blocks of the 200 total blocks on or near biologically sensitive areas of the topographic features in the Western Gulf. This alternative is presented as an environmental protection measure should the stipulation not be adopted.

(3) Alternatives Not Included in the EIS

Deletion of Tracts in More Than 2,400 M: Although some areas of the Gulf of Mexico in greater than 2,400 m of water are considered prospective, no leasing has occurred to date in such water depths. The technology to safely conduct hydrocarbon exploration in greater than 2,400 m of water exists and the ability to safely produce in such water depths would be expected to develop rapidly should a discovery be made.

Deletion of Area of Low Potential for Hydrocarbon Resources: The areas identified as having low potential for hydrocarbon resources in the Central and Western Gulf of Mexico occur in the deepwater Gulf seaward of the Sigsbee Scarp. Few structures favorable for hydrocarbon entrapment are present in the area, and sands are rare in the stratigraphic section. It is considered unnecessary to discuss deletion of an area where no industry interest has been shown and leasing is unlikely to occur.

Delay the Action: There are usually no apparent consequences of a delay of less than one year. Therefore, in the Central and Western Gulf, where sales are scheduled one year apart, a delay for a meaningful period, i.e., over one year, would be no different than canceling the sale.

b. Proposed Mitigating Measures Included in the EIS

Protection of Biological Resources (Topographic Highs and Live Bottoms): The topographic highs stipulations are designed to protect the sensitive biota associated with the various banks of the Central and Western Gulf of Mexico. The stipulations impose operating restrictions on oil and gas activities near identified banks in the form of no activity zones and zones in which shunting are required. The live bottom stipulation is designed to protect the pinnacle trend environment in the Central Gulf of Mexico. The stipulations require that a live bottom survey be conducted to identify potential live bottoms. Mitigating measures are imposed if significant live bottoms are identified. The stipulations and a discussion of their effects are located in Section II.A.1.c.(1) and (2) for the Central Gulf and Section II.B.1.c.(1) for the Western Gulf.

Protection of Archaeological Resources: The archaeological survey requirement of the stipulation will be applied to all leases which fall within archaeological resources zones 1 and 2. Zone 1 has a high potential for the occurrence of historic shipwrecks and for prehistoric sites. Zone 2 has a high potential only for prehistoric sites. The stipulation serves to reduce the potential for development related impacts to archaeological sites by requiring remote sensing surveys within archaeological zones 1 and 2 prior to lease developments. These surveys, by recording evidence of potential archaeological resource locations, makes avoidance or mitigation of impacts possible. The stipulation and a discussion of its effects are located in Section II.A.1.c.(3) for the Central Gulf and Section II.B.1.c.(2) for the Western Gulf.

Mitigation of Conflicts with Military Activities: A stipulation will be applied to all leases within the designated military use/warning areas. The effect of the stipulation will be to reduce potential conflicts between military missions and service boat traffic and helicopter flights. The stipulation and a discussion of its effects are located in Section II.A.1.c.(4) for the Central Gulf and Section II.B.1.c.(3) for the Western Gulf.

Information to Lessees (ITL) Concerning Conflicts with the Gulf Ocean Incineration Site: A potential ITL is included that, if adopted, would caution lessees in the Final Notice of Sale for Sale 112 of the existence and location of the U.S. Environmental Protection Agency (USEPA) administered Gulf Ocean Incineration Site. The ITL also advises lessees to contact USEPA so potential conflicts can be avoided through coordination. The ITL, a discussion of its effect, and a map of the Gulf Ocean Incineration Site are in Section II.B.1.e.(1). A description of the current status of ocean incineration in the Gulf is in Section I.B.2.c.(2).

c. Issues

(1) Issues Analyzed in the EIS

Selection of environmental and socioeconomic issues to be analyzed was based on the following criteria:

- The resource/activity was identified through scoping or comments on a draft EIS.

- The resource/activity must be vulnerable to one or more important impact producing factors (IPF's). To be vulnerable, the location and temporal aspects of the resource/activity must be such that an interaction with an IPF could occur. A reasonable probability of such an interaction should exist.

- The potential must exist for a significant impact utilizing the following determining factors: sensitivity of the resource to IPF's; quantity, scarcity, and uniqueness of the resource.

Using these criteria, it was determined that the following eight issues require in-depth analysis. All major direct, indirect, and cumulative impacts of the indicated IPF's on the specific concerns are analyzed; other major non-OCS IPF's affecting the identified concerns are evaluated as part of the cumulative impact analysis. All issues were the subject of responses to scoping for this EIS.

Impact Topic	Description	Location in EIS
Sensitive Coastal Habitats a. Barrier Beaches/Islands b. Wetlands	Barrier islands, wetlands, mangroves, and seagrasses may be affected. IPF's include oil spills, construction of navigation channels and canals, emplacement of pipelines, construction of onshore facilities, maintenance dredging, and vessel traffic.	Sections IV.D.1.a.(1) and IV.D.2.a.(1)
Sensitive Offshore Habitats a. High Topographic Features b. Live Bottom Areas	Topographic features and live bottom areas may be affected. IPF's include mechanical damage due to anchors, emplacement of drilling and support structures, drilling operations, and laying of pipelines; damage to the biota by smothering or by toxicity of drilling fluids, cuttings, produced water, oil spills, and resuspension of sediments due to a blowout.	Sections IV.D.1.a.(2) and IV.D.2.a.(2)
Water Quality a. Offshore b. Onshore	Onshore and offshore water quality may be affected. IPF's include discharges related to catastrophic events and onshore and offshore operations.	Sections IV.D.1.a.(3) and IV.D.2.a.(3)
Air Quality	Onshore and offshore air quality may be affected. IPF's include emissions from catastrophic events and onshore and offshore operations.	Sections IV.D.1.a.(4) and IV.D.2.a.(4)
Endangered and Threatened Species a. Brown Pelicans b. Marine Mammals (Whales) c. Sea Turtles	Sea turtles and brown pelicans may be affected. IPF's include oil spills, increased vessel and air traffic, and onshore facilities construction.	Sections IV.D.1.a.(5) and IV.D.2.a.(5)

Coastal and Marine Birds	Coastal and marine bird species or regional populations may be affected. IPF's include oil spills, increased vessel and air traffic, and onshore facilities construction.	Sections IV.D.1.a.(6) and IV.D.2.a.(6)
Commercial Fishing Industry	The economy of the commercial fishing industry may be affected. IPF's include oil spills, gear conflicts, and platform emplacement.	Sections IV.D.1.a.(7) and IV.D.2.a.(7)
Major Shorefront Recreational Beaches	Shorefront beaches supportive of intensive recreational activity may be affected. IPF's include trash and debris, oil spills, tar balls, pipeline landfalls, and onshore facilities construction.	Sections IV.D.1.a.(8) and IV.D.2.a.(8)
Archaeological Resources a. Historic b. Prehistoric	Unique historic and prehistoric archaeological data may be affected. IPF's include emplacement of offshore and onshore infrastructure, oil spills, and oil spill clean-up activities.	Sections IV.D.1.a.(9) and IV.D.2.a.(9)

(2) Issues Not Analyzed in the EIS

Through recent scoping activities and as a result of prior analysis in past EIS's, the following topics have been determined not to be significant environmental issues which would require in depth analysis in this EIS for the reasons given below.

Community Infrastructure

The topic may be described as concern over the increased demand on existing community facilities systems and capacity due to an increased level of oil and gas activities. Such systems commonly include public, semi-public and private services and facilities, such as education, police and fire protection, utilities, etc. Should these conditions occur, potential adverse socioeconomic impacts may result.

This concern last received public comment on Draft EIS 94/98/102 from the Louisiana Department of Natural Resources. The comment, however, centered on the effects of past oil and gas leasing as opposed to the effects of the proposed sales.

Our analyses for that sale, as well as subsequent sales, have indicated very low potential impacts resulting from proposed leasing actions each year. Essentially, the analysis indicates the lease sale may result in a net population increase of less than one thousand distributed throughout the coastal area. Community infrastructure already in-place has sufficient capacity to accommodate this minor population change. No new data are noted that would change the impact assessment and no public comment expressing concern over this issue has been noted recently.

Local Economic Conditions

Concern exists over the probability that OCS-generated employment in adjacent coastal communities may adversely affect local economies. In particular, the State of Louisiana commented on Draft EIS 94/98/102 and expressed concern over the possible "boom/bust" economic impact from areawide sales.

The proposed action may generate direct, secondary, and induced employment. Direct employment includes jobs associated with the oil and gas extraction industry; secondary employment includes jobs associated with oil- and gas-related industries; and induced employment includes jobs supported by expenditures of direct and secondary employees.

MMS analysis for the Proposed 5-Year OCS Oil and Gas Leasing Program indicates that job opportunities created by sales proposed for the 1987-1991 time period will allow a continuation of some existing oil/gas-related jobs in the CPA and WPA rather than attract new residents into the region. Therefore, the 1987 lease sales, which are a part of that 5-year lease sale schedule, are expected to result in no adverse impacts on local economic conditions. Instead, the continuation of some existing employment and income is considered beneficial.

Additionally, responses to the Call and NOI for the two sales did not reveal any major concern over adverse local economic impacts. Also, no comments on our analysis and conclusion for this issue were received for Draft EIS 104/105.

Marine Mammals

All marine mammals are protected under the Marine Mammal Protection Act of 1972; some marine mammals are also protected under the Endangered Species Act of 1973. About 28 species of marine mammals occur in the Gulf region (Table III-5). The bottlenose dolphin is the most abundant nearshore marine mammal species in the Gulf. Although the endangered sperm whale is uncommon in the Gulf (Mead, 1975), it is probably the more numerous large marine mammal in this region. Recent studies by Geraci and St. Aubin (1985) indicate that oil spills may not have a significant impact on marine mammals.

The major impact producing agents which would potentially affect marine mammals are: seismic activities, oil spills, and collisions with offshore crew/supply vessels. Some seismic activity will result from the proposed action; noise associated with seismic activity is usually short-term and localized in the vicinity of the seismic vessel. Electric discharge or nonexplosive airgun have replaced explosives as sound sources for seismic activities. Drilling and other noise from offshore platforms are usually localized around the drill site. It is unlikely that noise from seismic activities or drilling will have a significant impact on marine mammals.

The oil spill risk analysis indicates the highest probability of one or more spills (1,000 bbls or greater) occurring and contacting any particular land segment within 10 days of a spill is 9% for Terrebonne Parish, Louisiana. One oil spill is predicted to occur as a result of the proposed action. Considering the low probability of occurrence it is unlikely that oil spills resulting from the proposed action will have a significant impact on marine mammals.

Vessel traffic related to offshore oil/gas activities is estimated to be about 2% of the existing annual vessel traffic in the Gulf. It is unlikely there will be an increase in offshore vessel traffic as a result of this proposed action. No collisions between offshore service vessels and marine mammals have been reported in the Gulf of Central or Western Mexico.

The potential impacts to whales will be discussed in the endangered species section in Sections IV.D.1.a.(5)(b) and IV.D.2.a.(5)(b).

Marine Transportation

The Gulf is used extensively for marine transportation involved in international and domestic commerce, commercial and recreational fishing, military operations, and other activities. The topic may be described as concern over whether or not increased OCS oil- and gas-related vessel traffic will adversely impact navigational safety in the Gulf and whether changes in current traffic patterns may be necessary due to OCS activity.

The impacts of past sales have been thoroughly analyzed in all four draft and final EIS's produced since then. These analyses have shown that, due primarily to the established fairway system and regulations requiring adequate marking of structures, the impacts are generally low and considered manageable.

No concerns about impacts of the OCS program on marine transportation have been expressed during the scoping process for any of the last three EIS's, and only one minor comment has been made on any of the three draft documents. Furthermore, the topic is not "environmental" in nature, being actually more economic in its general relationship.

Military Areas

There are three designated military warning areas and portions of two water test areas in the Central Gulf. These areas are used for various military activities which could be affected by OCS oil and gas operations. A standard military area stipulation has been developed through consultation with the Department of Defense (DOD) that helps to manage and mitigate potential multiple-use conflicts. The only area in the Central Gulf that has ever been an issue of concern is Warning Area 155. Negotiations with DOD have resulted in transference of their military operations to the Eastern Gulf thereby eliminating a need for a special stipulation or deferral of W-155 from oil and gas leasing in the Central Gulf at this time.

There are two military warning areas in the Western Gulf. The standard Military Area Stipulation is also applicable to these areas. Warning Area W-228 has been of concern to DOD due to the extensive oil and gas development in the area, but they have implicitly agreed to allow unrestricted development to continue in the area as long as development is restricted elsewhere in Warning Areas W-155 and W-174 in the Eastern Gulf. When W-228 in the Western Gulf becomes so developed that it must be abandoned for carrier operations, these operations will be moved to W-155 and W-174.

The U.S. Navy is currently in the process of preparing an EIS on its Proposed Gulf Coast Strategic Home Porting Plan. The plan, if implemented, may require the Navy to reevaluate its previous positions on leasing in the Central and Western Gulf. Past issues have been successfully negotiated to the general satisfaction of both DOI and DOD, and it is expected that the open lines of communication will serve to resolve future conflicts as well.

The joint-use problems of oil and gas leasing in military areas are not environmental in nature and have always been resolved outside of the EIS process. Therefore, the issue is not considered to be of major significance to the proposed actions for Sales 110 and 112.

Offshore Marine Recreational Fishing Activities

Recreational fishing activities have historically been found to be a positive impact from oil and gas related platforms located within areas accessible to offshore fishermen. Because current leasing has occurred at greater distances from shore and because there are a great many platforms already accessible to fishermen, it is believed that any new platforms will only have minor incremental benefits. This issue has lost its former significance because extensive and definitive studies off Louisiana and Texas have shown that oil and gas structures attract fish and fishermen and significantly improve recreational fishing. These beneficial effects have been thoroughly analyzed in previous EISs and, therefore, any conflicts with offshore marine recreational fishing activities will be considered as a minor concern rather than a major issue in this EIS.

Ports

Many of the ports located along the coast of the Central and Western Gulf are involved to some extent in activities associated with the exploration, development, and production of oil and gas in the Gulf. The topic of interest is the impact of the OCS program on these ports due to the demand for additional port and harbor space which generally involves temporary and permanent service bases and facilities necessary for the shipment of platform and pipeline materials.

The impacts have been analyzed in all four draft and final EIS's produced since 1981. Many of the ports were developed to support the oil and gas industry and have been, and still are, actively competing for business. New major incremental demands on space are not taking place. Land for these ports has already been cleared and bulkheaded, and any additional use requirement on existing ports would be considered a positive economic impact.

No concerns about impacts of the OCS program on ports have been expressed during the scoping processes for any of the last three EIS's, and no comments have been made on any of the three draft documents. Furthermore, the topic is more economic than it is environmental in nature.

Seagrasses

Concern exists over the impacts to seagrasses by oil and gas industry activities. Seagrasses only occur in patchy areas nearshore throughout the Central and Western Gulf region and are abundant only in offshore areas in the Eastern Gulf. Those located in the Eastern Gulf would not be impacted from any oil and gas activity resulting from the proposed actions. Seagrasses are very important for fish, crustaceans, and green turtles, and they constitute an important link in marine food webs. Studies indicate the major impact producing factors are oil spills and dredging for pipelines and navigation channels. However, oil generally affects only the intertidal seagrass beds; subtidal seagrasses usually are not affected by oil. Dredging for pipelines and navigation channels can damage or permanently destroy seagrass areas by displacement and/or smothering. Seagrass areas that have been damaged or destroyed will sometimes be reestablished from adjacent areas within 1 to 3 years, depending on the severity and extent of the damage. In some situations the seagrasses are permanently lost.

The following two comments were received on Draft EIS 104/105 regarding concern over seagrasses: the Sierra Club was concerned with the potential for seagrasses to become oiled, and what measures would be taken to ensure reestablishment of these areas impacted from potential spills; and USEPA questioned previous assumptions that pipeline emplacement would only temporarily affect seagrasses and suggested that such an assumption may not be valid due to the number of factors affecting their recovery. However, the magnitude of the potential involvement of seagrass beds in the CPA and WPA is so minor (less than 0.2%) that the issue does not warrant intensive study in these regions.

State and Local Land Use Management

The topic may be described as concern over the possibility that OCS activity resulting from the proposed action may cause an increase in the level of OCS oil and gas activity which, in turn, may cause growth and development in the coastal zone to occur at such an accelerated rate that State and local governments may be unable to plan effectively for the land use changes, and an inefficient and disorderly use of land and coastal environmental resources would occur.

This concern last received public comment in 1981 as a result of the Regional EIS for Sales 72/74/79. Our analysis for those sales, as well as subsequent sales, have assessed very low impacts. No new data have become available that would change the impact assessment, and no public comment expressing concern over this issue has been noted recently. Land use studies are currently underway and may provide new data in forming impact assessments. Current indications are that land use is not a major or significant issue.

Water Supply

Previous analyses have shown that large quantities of freshwater are used both offshore and onshore to support a number of OCS-related activities. Such activities are varied and consist of drilling operations, platform fabrication, and oil/gas processing. Despite the quantities appearing to be quite large, in respect to the daily industrial uses on a county/parish basis, the previous proposal estimates equate to less than 0.1% of their daily use. Therefore, the previous proposals have had a very low to negligible impact to regional water supplies.

Also, the question of whether there will be sufficient water to support future oil and gas operations in the Gulf is addressed in detail subsequent to the lease sales, at the time the required Exploratory Drilling Plans are submitted to the States for review and approval. These plans describe proposed offshore and onshore operations and facilities and other requirements, including the estimated amount of water consumption. States with approved coastal zone management (CZM) plans are required to make a determination that the proposed exploration plan is consistent with the CZM plans and historically all plans have been found to be consistent. This procedure assures that State and local officials have the opportunity to review and approve, or disapprove, water use elements before they became large and unmanageable.

Gulf Ocean Incineration

This topic relates to the multiple uses of oil and gas leasing and ocean incineration within a USEPA designated Gulf site consisting of 224 blocks located in the Western Gulf, primarily in the Alaminos Canyon and Keathley Canyon leasing areas (Figure I-2). Limited test incinerations have already been conducted and, therefore, USEPA considers ocean incineration as an existing use of the area and that leasing in the site would be an impact producing factor.

USEPA has expressed concern through its comments on the Draft and Final EIS's for Sales 104/105 that should leasing and incineration both occur in these 224 blocks, potential conflict would exist between these two uses within the site. Two potential hazards could occur at the burn site: a collision between the incineration vessel and drilling rigs; and a human health risk to offshore workers due to the formation and emission of hazardous compounds which are not present in the original waste. They also recommended that blocks within the designated site be deferred from leasing and that blocks in a surrounding unspecified buffer be stipulated with a cautionary notice which would alert lessees that incineration may occur within the site. However, space use conflicts have not occurred and are expected to be coordinated out of both agencies' operations so that significant environmental effects will not result.

The MMS Gulf OCS Region does not consider the potential for use conflicts as a significant issue for the following reason: no further incineration will be permitted until promulgation of the final ocean incineration regulations. Public concern over the location of incineration ship base ports is high and could cause problems in establishing incineration bases. Because of this high public concern, the final promulgation of USEPA regulations

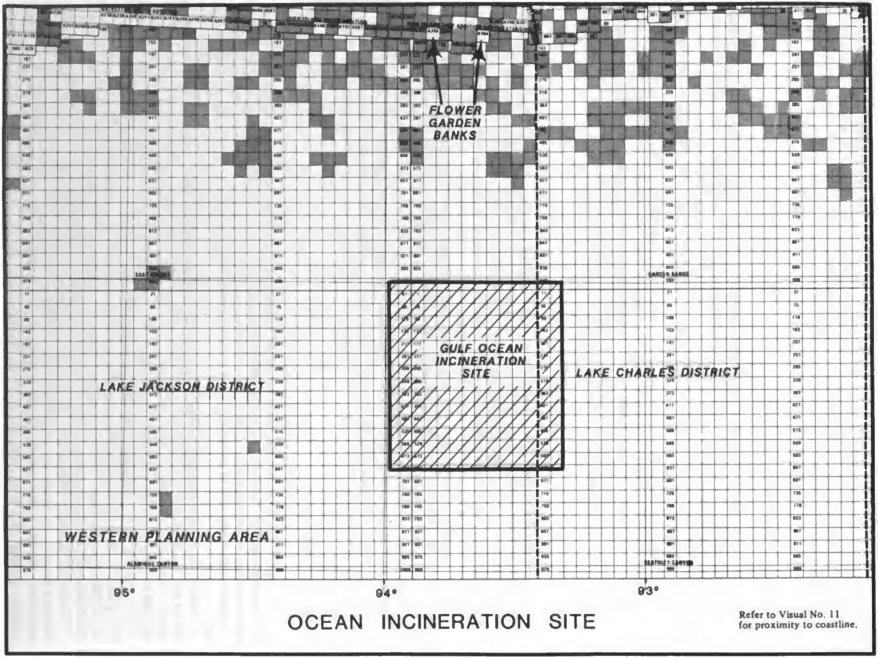

FLOWER
GARDEN
BANKS
GULF OCEAN
INCINERATION
SITE
LAKE JACKSON DISTRICT
LAKE CHARLES DISTRICT
WESTERN PLANNING AREA
95°
94°
93°
OCEAN INCINERATION SITE
Refer to Visual No. 11
for proximity to coastline.

Figure I-2

and their implementation is not expected to occur in the foreseeable future. The incineration site is approximately 1,800 square miles, and regulations allow only one ship be permitted to perform incinerations at any time. Additionally, when conditions are favorable, an incineration ship heads into the wind with enough power to maintain steerage and allows the existing wind to carry the incineration emissions away from the ship. Therefore, the ship uses only a small portion of the designated site during an individual burn. Drilling and incineration can be coordinated so that each could occur within the site at the same time in different locations. At the Fall 1985 Regional Technical Working Group (RTWG) Meeting, the Offshore Operators Committee iterated the industry's position that oil and gas exploration and development and ocean incineration should be compatible uses of the Gulf and that industry does not view ocean incineration as dangerous to the offshore workplace. Also at that same meeting, the U.S. Coast Guard (USCG) expressed concern for safety in the marine environment but did not view multiple use as one of their major concerns.

The Region sent a scoping request to USEPA for data which could be used in an analysis; their written response has not been received. However, communication with a USEPA representative indicated that the information concerning future incineration in the site is virtually impossible to estimate. Other data concerning the extent of the effects of incineration are unavailable pending future USEPA studies.

Also, negotiations are ongoing with USEPA concerning leasing at the existing site. MMS has recommended the inclusion of an ITL in the Notice of Sale for Proposed Western Gulf Sale 112 which would alert bidders to the existence of the site and which would recommend coordination between the lessee(s) in the site and USEPA.

Hurricane Hazards

Hurricanes are a natural phenomenon that have a long history of occurrence in the Gulf of Mexico. Hurricanes are not due to OCS development and therefore are not a direct impact of OCS leasing. Advanced weather forecasting techniques and modern communication have minimized the effect of these major cyclonic disturbances on human activity, including oil and gas operations on the OCS. Improved offshore platform design, evacuation plans, flood protection devices, and a wide range of contingency plans provide for the safety of both offshore industry personnel and the general public (DeWald, 1980). Natural disaster components such as state and local Civil Defense, the individual state National Guard units and the USCG remain alert to deal with hurricane hazards. Although hurricanes can add to environmental hazards due to oil and gas development, a platform verification program promotes the integrity of design for oil and gas platforms which protects against hurricanes. As a comparative background assessment, the staff of MMS is currently working on a report on impacts to the Gulf Coast region from the major hurricanes of 1985. See Appendix D for a synopsis of impacts from the 1985 hurricanes.

3. Regulatory and Administrative Framework - Department of the Interior

a. Presale Activity

Each planning area in the Gulf is divided along the 900 m depth contour line into two lease term areas. Blocks on the shoreward side of the line are leased for 5 years and blocks on the seaward side are leased for 10 years. The 10-year lease term allows industry more flexibility in meeting the technical challenges of operating in deepwater. The 5-year/10-year lease term line is shown on Figure 1-3 of Final EIS 104/105. Recent lease sales in the Central and Western Gulf of Mexico have included an 8-year lease term for blocks located between 400 m and 900 m water depths (Appendix G of Final EIS 104/105). For each lease that falls within these depths, the lessee must commence the drilling of an exploratory well within 5 years of the date the lease becomes effective.

(1) Federal/State Coordination

The DOI has the responsibility to perform certain regulatory and administrative functions during the presale stage. The OCSLA requires the Department to coordinate with state and local governments prior to actual leasing when their states may be affected by oil and gas activities. Specific timeframes are developed during which the Secretary provides information to the states and they, in turn, have opportunities to comment and coordinate with the Secretary.

For a more complete description of this coordination process, see Volume 1, Section I.B.3. of the Final Regional EIS.

(2) Geological and Geophysical Activity Regulations/Coordination

Geological and geophysical (G&G) surveys and analyses provide most of the resource and hazards information used by government and industry on the oil and gas potential of offshore areas. The collecting of G&G data begins prior to the leasing of Federal land and continues throughout the offshore mineral leasing process.

Pursuant to 30 CFR 251.4, permits must be obtained in order to conduct either geological or geophysical exploration for mineral resources or geological or geophysical scientific research of areas of the Gulf OCS. "Geological exploration for mineral resources" means any operation conducted on the OCS which utilizes geological and geochemical techniques, including, but not limited to, core and test drilling, well logging techniques, and various bottom sampling methods to produce information and data on mineral resources, including information and data in support of possible exploration and development activity. "Geophysical exploration for mineral resources" means any operation conducted on the OCS which utilizes geophysical techniques, including, but not limited to gravity, magnetic, and various seismic methods, to produce information and data in support of possible exploration and development activity. "Geological or geophysical scientific research" means any investigation conducted on the OCS using solid or liquid explosives, or drilling activities for scientific research purposes involving the gathering and analysis of geological or geophysical information and data which are made available to the public for inspection and reproduction at the earliest practicable time (30 CFR 251.2(n), (o), and (p)).

Permit applications for G&G activity must be submitted to the Minerals Management Service (MMS) in accordance with the requirements outlined in 30 CFR 251.5 and 30 CFR 251.6. The regulations under 30 CFR 251 do not apply to G&G exploration activities conducted by or on the behalf of the lessee on a leased block on the Gulf OCS. Geological and geophysical activities on existing leases are governed by the regulations in 30 CFR 250. The Gulf coastal states are not involved in the review process for specific G&G applications prior to issuance of the permit, except for Deep Stratigraphic Tests (DST's). Environmental reports are required in accordance with 30 CFR 251.6-2 for DST's, and, when required under a coastal zone management program, must receive State concurrence prior to approval of any activities covered under the permit. The plan and report would be made available to appropriate Federal agencies and the public in accordance with established practices and procedures.

After receiving the G&G permit application, MMS prepares either a categorical exclusion review (CER), environmental assessment (EA), or EIS in accordance with applicable MMS policies and guidelines, as described in Section I.B.3.b.(1)(a). A CER is prepared for most G&G permit applications. Exceptions to the categorical exclusion process, automatically requiring the preparation of an EA, are those activities which include the drilling of DST holes, involve the use of solid or liquid explosives, or which otherwise have the potential to significantly affect the quality of the human environment.

b. Postsale Activity Regulation/Coordination

MMS is responsible for regulating and monitoring the oil and gas operations on the Federal OCS. The regulations at 30 CFR 250.11 provide for the Director to regulate all operations conducted under a lease or permit and to issue or amend OCS Orders and other rules as may be necessary to supervise operations and, to prevent harm or damage to, or waste of any natural resource, life, property, or the marine, coastal, or human environment. "The Offshore Gulf of Mexico Operational Handbook" (OCS Report/MMS 84-0034) was prepared to serve as a guide to MMS required regulations and procedures (Marsh, 1984). Prior to either exploration, development, or production activities being conducted in a lease block, other than preliminary activities such as G&G activities, companies must submit plans to MMS for review and approval. Within these plans, specific requirements must be met relative to operating conditions and environmental considerations. The following references should be used for further information on Gulf of Mexico postsale activity regulation/coordination:

30 CFR 250.34-1, 2, and 3	Exploration Plans, Development and Production Plans, and Environmental Reports
30 CFR 250.57	Air Quality

MMS Gulf of Mexico Region Instructions of:

January 29, 1979	Plan Requirements
May 5, 1980	Air Emissions Requirements
June 2, 1980	Environmental Report (ER) Guidelines (NTL 80-6)
November 20, 1980	CZM ER Requirements
May 13, 1981	CZM and Supplemental Plans (Louisiana)
October 22, 1981	CZM and Supplemental Plans (Mississippi)
October 1, 1982	Cultural Resource Requirements (NTL 75-3, Revision No. 1)
September 2, 1983	Public Notice for Louisiana CZM
September 22, 1983	Shallow Hazards Requirements (NTL 83-3)
February 10, 1984	Development Operations Coordination Documents - Western Gulf - Plan Requirements (NTL 84-1)
July 17, 1984	Cultural Resource Requirements
December 20, 1984	Effect of Military Windows
February 4, 1985	Environmental Information - Flower Garden Banks
October 3, 1985	Change in Number of Plans Required Based on Agreement with the National Marine Fisheries Service and Military
November 26, 1985	Minimizing Oil and Gas Structures
January 24, 1986	Effect of Military Windows
March 5, 1986	Cultural Resource Requirements
Pipeline Guidelines and Procedures	OCS Report/MMS 84-0015
30 CFR 256, Subpart N	Grants of Pipeline Rights of Way
Guidelines for Photodocumentation Surveys	

(1) Review, Coordination, and Approval of Exploration, Development, and Production Activities

(a) Exploration Plans

Pursuant to Section 11 of the OCSLA and 30 CFR 250.34-1 and 3, an exploration plan and environmental data (e.g., ER, archaeological data, and biological monitoring plan, if required) must be submitted for approval to MMS before an operator may begin exploratory drilling on a lease. The plan describes all exploration activities planned by the operator for a specific lease(s), the timing of these activities, information concerning drilling vessels, platforms, or other structures to be used, and other relevant information. Pursuant to 30 CFR 250.34(a) and NTL 83-3, each exploratory drilling plan is accompanied by a shallow hazards analysis.

The ER analyzes both offshore and onshore impacts that may occur as a result of implementation of the plan. In accordance with the Coastal Zone Management Act of 1972 (CZMA), as amended, exploration plans and certain supplemental exploration plans must contain a certification of consistency with approved CZM programs of states which could be affected by the exploration activities. States with approved programs may take up to six months for consistency reviews but must agree with or request an extension within three months after receipt of their copy of the plan. In the Gulf of Mexico, Louisiana, Mississippi, Alabama, and Florida have Federally approved CZM programs. ER guidelines and environmental information requests for lessees and operators submitting an exploration plan are discussed further in Section I.B.3.b.(1)(c).

MMS prepares a CER, EA, or EIS based on all available information including the submitted plan; ER; archaeological reports, air emissions data, live bottom survey/report, and biological monitoring plan (when required); previous environmental documents and comments; and recommendations by the affected State(s), the Department of Defense, the U.S. Fish and Wildlife Service (FWS) (for selected plans under provisions of DM 655), the National Marine Fisheries Service (NMFS) for selected plans, and internal MMS offices. MMS evaluates the proposed activity for potential impacts relative to geohazards and man-made hazards (including existing pipelines), archaeological resources, endangered species, sensitive biological features, water and air quality, and other uses (e.g., military operations) of the OCS.

CER's are prepared for certain postlease activities in the WPA, CPA, and western part of the Eastern Planning Area (EPA) in accordance with Appendix 1 of 516 DM 2 and 516 DM 6, Appendix 10. That western portion of the EPA is offshore the State of Alabama from the CPA/EPA common boundary eastward to the offshore extension of the Alabama/Florida common boundary for State waters at approximately 87°31' west longitude (consult Visual No. 1 for further details). The criteria used to determine which actions are to be excluded from the NEPA process follows: the action or group of actions would have no significant effect on the quality of the human environment; and, the action or group of actions would not involve unresolved conflicts concerning alternative uses of available resources. The CER's do serve as a vehicle for a considerable environmental analysis in cases where archaeological assessments, air quality assessments, and biological assessments are necessary in early planning.

If the CER determines that the proposed action is an exception to the categorical exclusions as listed in 516 DM 2, Appendix 2, then the preparation of an EA is required. An EA may also be prepared on any action at any time in order to assist in planning and decisionmaking (516 DM 3.2.B) or under extraordinary circumstances (516 DM 2.4). EA's are prepared for actions in the Eastern (frontier) areas of the Gulf of Mexico (offshore Florida), for selected environmentally sensitive areas (e.g., for activities proposed within the four-mile zone of the Flower Garden Banks blocks; see Figures I-3 and I-4), and for proposed activities considered environmentally sensitive (e.g., new or unusual technology and pipeline corridors to shore).

If the EA indicates that approval of the plan would constitute a major Federal action significantly affecting the human environment and an existing EIS addressing the matter does not exist, an EIS must be prepared. On the basis of the EA, CER, or EIS findings and the plan completeness review, the exploration plan will be either approved, disapproved, or modification of the plan will be required of the operator.

An Application for Permit to Drill (APD) is filed by the lessee/operator along with or subsequent to submission of the Exploration Plan and supporting information. The APD requires detailed information about the drilling program for evaluation with respect to operational safety and pollution prevention measures. Approval of an APD requires an MMS-approved Exploration Plan and receipt of CZM consistency or presumptive concurrence. The approved APD constitutes the drilling permit. Significant deviations from the approved plan require that an environmental analysis be done in accordance with the procedures outlined earlier. Other permits required prior to exploratory drilling include permits for aids to navigation from the U.S. Coast Guard (USCG), permits for installation of structures attached to the seabed from the U.S. Army Corps of Engineers (COE), and National Pollutant Discharge Elimination System (NPDES) permits from USEPA.

(b) Development and Production Plans

Development and production plans are not required for leases in the Western Gulf pursuant to 30 CFR 250.34-2(a)(2), effective January 13, 1984. (In this designation, the Western Gulf includes all areas of the Gulf of Mexico except those that are adjacent to the State of Florida.) However, information covering these leases is required to ensure conformance with the OCSLA, other laws, applicable regulations, and lease provisions and to enable MMS to carry out its functions and responsibilities. Therefore, prior to any development and production activity being conducted on a lease in the Western Gulf, the operator must prepare and submit to MMS a Development Operations Coordination Document (DOCD), and, as required, an environmental report, archaeological report, or biological report (monitoring and/or live bottom survey), etc., or other environmental data determined necessary. A DOCD shall be considered a development and production plan for the purpose of any references in any law, regulation, lease provision, agreement, or other document referring to the preparation or submission of a plan. Information to be submitted for DOCD's is outlined in the Notice to Lessees (NTL) 84-1 effective February 10, 1984.

After receiving the Plan of Development/Production or DOCD, MMS prepares either a CER, EA, or EIS as discussed under Exploration Plans above. As part of the review process, the Plan and the ER as required are sent to the affected state(s) with an approved CZM plan for consistency certification review and comment. Section 19 of the OCSLA provides for coordination and consultation with the affected states and local governments concerning a development plan. Under Section 19 of the Act, recommendations are required to be submitted within 60 days after receipt of a development plan. ER guidelines and environmental information requirements for lessees and operators submitting a development and production plan are addressed in NTL 80-6 and are discussed further in Section I.B.3.b.(1)(c). On the basis of the CER, EA, or EIS findings and the plan completeness review, the development/production plan will either be approved, disapproved, or modification of the plan will be required of the operator.

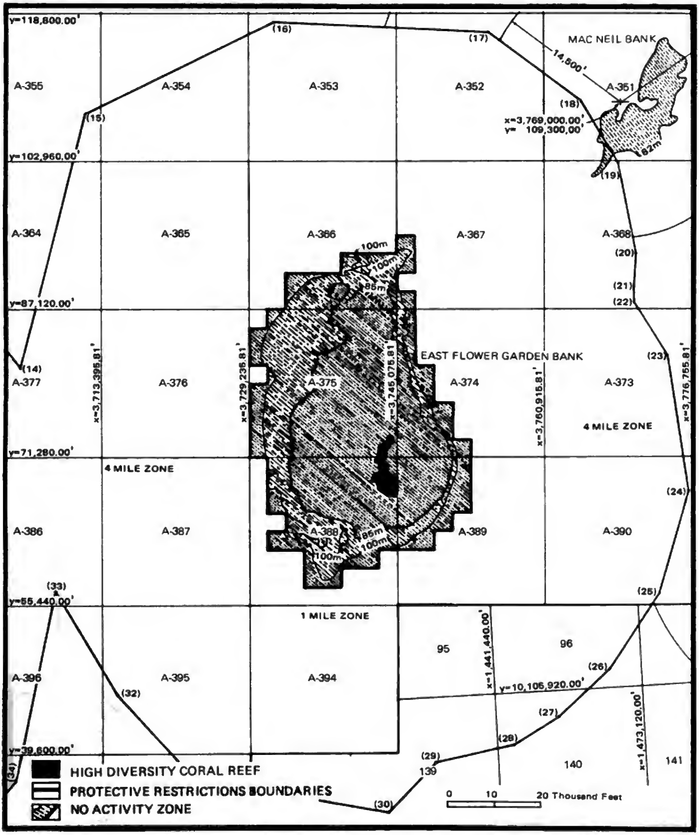


Figure 1-3. East Flower Garden Bank, showing "No Activity Zone," "1 Mile Zone," and "4 Mile Zone." East Flower Garden Bank is in the High Island, East Addition, South Extension, Lease Area.

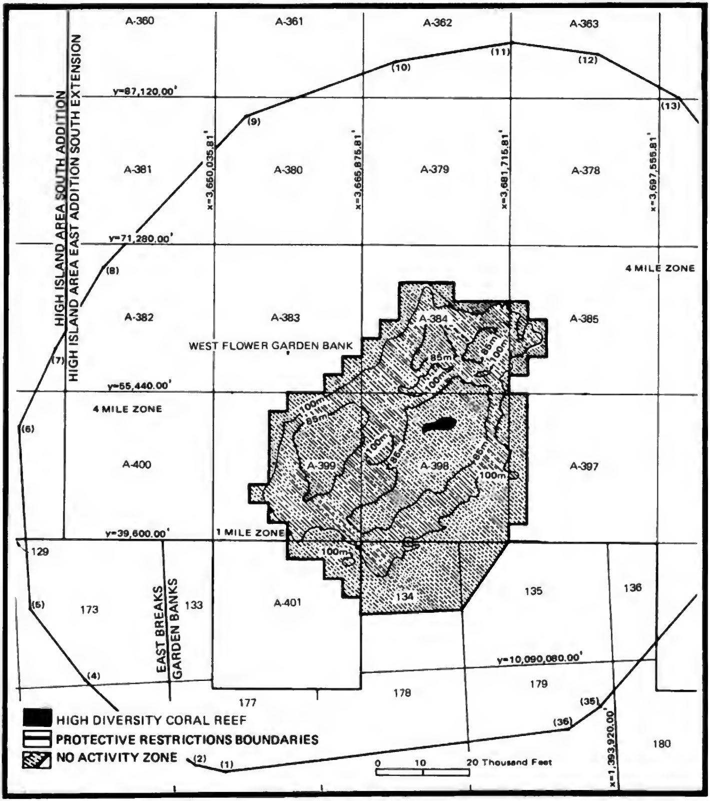


Figure 1-4. West Flower Garden Bank, showing "No Activity Zone," "1 Mile Zone," and "4 Mile Zone." West Flower Garden Bank is in the High Island, East Addition, South Extension Lease Area.

After the approval of the plan, the operator submits to MMS specific applications, such as those for lease-term pipelines and platforms, to conduct activities described in the plan. Additional applications submitted for approval to various Federal agencies include those to the USCG for aids to navigation, COE for navigation and platform installation permits, and USEPA for NPDES permits.

(c) Environmental Reports/Information

ER's are submitted by operators for proposed exploration and/or development and production activities in the Eastern Gulf of Mexico and for CZM purposes in accordance with NTL 80-6. Under the CZMA, each state that has an approved CZM plan has the option to require information for inclusion in the ER which is different than that specifically outlined in 30 CFR 250.34-3. The States of Louisiana, Mississippi, Alabama, and Florida have approved CZM programs. With the exception of Florida, abbreviated ER's are submitted by operators for CZM purposes.

Additional environmental information may also be required for plans/activities in the Western Gulf of Mexico for: (1) areas of high seismic risk or seismicity and relatively untested deepwater and remote areas; (2) areas proposed or established as a marine sanctuary and/or near the boundary of a proposed or established wildlife refuge or areas of high ecological sensitivity (e.g., Flower Garden Banks); (3) areas of potentially hazardous natural bottom conditions; or (4) the use of new or unusual technology, when the additional information is required to evaluate impacts. The Letter to Lessees dated February 4, 1985, outlines information for activities proposed within the four-mile zone of the Flower Garden Banks. Additional environmental information deemed necessary for No. 3 of NTL 80-6 would be determined on a case-by case basis, in accordance with 30 CFR 250.34. The submission of specific environmental data to aid in evaluating the environmental impacts of plans/activities may be required by MMS under 30 CFR 250.34-1(a)(2)(ii) and 30 CFR 250.34-2(a)(3)(ii) in areas of the Central and Western Gulf where either no ER is required or an abbreviated ER is required for CZM purposes. Refer to Section I.B.3.a.(2) for a discussion of ER requirements for G&G operations, pursuant to 30 CFR 251.6-2.

(d) Pipelines

Operational procedures and requirements for OCS pipelines, as stipulated in the Pipeline Procedures Handbook (OCS Report/MMS 84-0015), are different for two major categories of lines, i.e., lease term and rights-of-way lines (USDI, MMS 1984b). Rights-of-way lines, for which annual right-of-way fees are paid, are not wholly contained within the boundaries of a single lease, unitized leases, or contiguous leases of the same owner or operator and are regulated under 30 CFR 256 Subpart N. Lease-term lines, for which no annual rental fees are charged, are wholly contained within the boundaries of a single lease, unitized leases, or contiguous leases of the same owner or operator and are regulated under 30 CFR 250.20.

MMS pipeline permit applications are filed under 30 CFR 256.92 or 30 CFR 250.20, whichever is applicable. Detailed requirements for filing the applications are found in the Pipeline Procedures Handbook. Normally, each permit application will contain the pipeline location drawing, profile drawing, safety schematic drawing, and the pipe design data. Information submitted as part of the geological and geophysical survey report for rights-of-way and lease term lines is used for MMS environmental evaluations. In considering applications for permits for both rental and nonrental lines, MMS approves the design and fabrication of the pipelines and prepares a CER, EA, or EIS in accordance with applicable policies and guidelines. MMS prepares an EA or EIS on all pipeline corridors which go ashore (516 DM 6, Appendix 10). Pipelines directly affecting the coastal zone of a state with an approved CZM program may not be approved unless they are consistent with the approved CZM program. FWS reviews and provides comments on applications for pipelines which are near sensitive biological features or which cross into State waters. Procedures for reporting pipeline damage are discussed in detail in NTL 80-9.

(e) Application for Permit to Drill

The APD is reviewed for conformance to the requirements of OCS Order No. 2 and other engineering considerations. Significant deviations from the approved plan require that an environmental analysis be done in accordance with the procedures outlined in Section I.B.3.b.(1)(a).

Checks are made of the proposed casing and cementing programs considering such items as the adequacy of the physical properties of the casing for the proposed setting depths, the selection of the casing setting depths relative to the anticipated formation fluid and formation fracture pressures, and the volume and type of cement to be used. Also, the drilling fluid type and density are checked for adequacy.

The lessee is required, as part of the APD, to submit information, including schematic diagrams, on certain safety devices used to prevent loss of well control. The size, number, and pressure rating of these devices is checked for adequacy.

(f) Platform Verification Program

A program has been established by MMS which is designed to assure that offshore oil and gas structures are designed, fabricated, and installed using standardized procedures to prevent structural failures. Lessees are required to submit detailed information on any proposed structure to be erected. The program facilitates review of these structures and utilizes third party expertise and technical input in the verification process through the use of a Certified Verification Agent. An environmental analysis would be conducted for any proposal involving the use of new or unusual technology.

(2) Regulatory Enforcement Measures

(a) Inspections

Drilling and production compliance inspections are conducted before, during, and after operations to assure compliance with lease terms, NTL's, and approved plans and to assure that safety and pollution-prevention requirements of regulations and OCS Orders are met. These inspections involve items of environmental concern. Further information on the baseline for the inspection of lessee operations and facilities can be found in the National Potential Incident of Noncompliance (PINC) List (USDI, MMS, 1984c). Noncompliance with checklisted requirements for specific installations or procedures are followed by prescribed enforcement actions, consisting of written warnings or shut-ins of platforms, zones (well), equipment, or pipelines. In some cases, more than one enforcement action is noted. The MMS inspector then determines the appropriate enforcement action based on an assessment of the risk of either pollution or accident, the history of the lessee, the stage of operation in progress, and the status of other systems. The primary objective of initial inspections is to assure proper installation of mobile units or structures and associated equipment. After operations begin, additional unannounced inspections are held. Depending on the distance from shore, MMS district personnel will visit and inspect from one to three different rigs or platforms per day. Aerial surveillance of additional offshore structures is conducted enroute.

(b) Special Inspection Procedures

The operator will normally request the use of oil-based muds at the APD stage if problems are anticipated or during drilling if problems are encountered. Approval is granted with the understanding that the cuttings will be treated (chemically) in the cuttings washer prior to dumping or collected and transported to shore for disposal. The latter method is used when only a small "plug" is needed to solve a problem (stuck drill pipe, etc.) or when the rig does not have the equipment to properly treat the mud.

Inspections are usually conducted for all rigs and platforms every 10-14 days, weather permitting. Inspectors try to visit operations using oil-based muds more often, or at least make an effort to "fly-by" when in the area.

Of initial importance to inspectors is the presence or absence of a "visible sheen" in the waters adjacent to a rig using oil-based muds. On-board inspection involves seeing that the muds and cuttings are being properly treated and/or disposed of. The "bucket test" involves dropping 2-3 handfuls of cuttings into a bucket of seawater to test for residual oil. The presence or absence of a "visible sheen" in the bucket determines whether or not the cuttings are being properly treated prior to being dumped.

District personnel inspect H2S sensors to make sure that they are operational, inspection logs for timely calibration of instruments and to ensure that rig personnel have been trained in appropriate equipment handling, safety regulations, and emergency procedures.

(c) Suspension of Operations and Cancellation of Leases

Section 5(a) of the OCSLA and regulations appearing in 30 CFR 250.12 provide for the suspension or temporary prohibition of an operation or activity:

(1) when the lessee fails to comply with the appropriate laws, regulations, or orders;

(2) when there is a threat of immediate harm or serious irreparable damage to life (including aquatic life), property, mineral deposits, or environment;

(3) when in the interest of national security or defense;

(4) for any purpose necessary for the implementation of the National Environmental Policy Act (NEPA); and

(5) at the request of the lessee if the Director determines that the request is in the national interest and will (a) facilitate proper development of the lease, (b) allow for construction or negotiation for the use of transportation facilities, or (c) facilitate installation of equipment determined necessary by the Director.

The Secretary may cancel a lease or permit if, after a hearing, he determines: (1) that continued activity would probably cause serious harm or damage to life, to property, the environment, or national security or defense; (2) that the threat of harm or damage will not disappear or decrease to an acceptable extent within a reasonable time; and (3) the advantages of cancellation outweigh the advantages of continued activity. A lease may be canceled only following suspension or temporary prohibition on a lease or permit continuously for a period of five years (or for a lesser period at the request of the lessee).

(d) Remedies and Penalties

Under Section 24 of the OCSLA and regulations appearing at 30 CFR 250.80, both civil and criminal penalties can be assessed for failure to comply with responsibilities under the law, a license, a permit, or any regulation or order issued pursuant to the Act. Further, under Section 5 of the OCSLA, the issuance and continuance in effect of any lease or of any assignment or other transfer of any lease shall be conditioned upon compliance with regulations issued under the OCSLA.

(3) Environmental Safeguards

(a) OCS Orders

OCS Orders are administered by MMS and deal specifically with technical matters or problems of a particular geographical area. They supplement regulations governing drilling and production operations on the OCS as listed in 30 CFR 250. The 14 Gulf of Mexico OCS Orders deal with operational aspects of OCS activities such as drilling operation rules and permit requirements, plugging and abandonment procedures, production safety systems on all OCS platforms,specifications for workover procedures, pollution prevention, and approval procedures for oil and gas pipelines on the OCS. For a more complete description of the OCS Orders, see Volume 1, Section I.B.3.b.(1)(f) of the Final Regional EIS. There currently is a plan to revise these OCS Orders and to incorporate them into regulations at 30 CFR 250.

(b) Lease Stipulations

Oil/gas exploration and development activities on the OCS have the potential for causing adverse environmental impacts; therefore, stipulations are developed prior to the sale (discussed under Sections II and IV in this document) and are attached to the lease instrument, as necessary, in the form of additional mitigating measures. Biological, archaeological resources, and military areas stipulations are those which have been attached most often to the leases in previous Central and Western Gulf lease sales. MMS is responsible for ensuring full compliance with stipulations appended to leases.

(c) Air Quality

Section 5(a)(8) of the OCSLA provides that the Secretary shall promulgate and administer regulations to provide for compliance with the National Ambient Air Quality Standards (NAAQS) pursuant to the Clean Air Act. This has been accomplished through 30 CFR 250.57 and administered by MMS as a postsale activity. It is the intent of 30 CFR 250.57 to protect onshore ambient air quality and to ensure that no new violations of the NAAQS are caused by the OCS activity. The criteria pollutants which are regulated are carbon monoxide, total suspended particulates, sulfur dioxide, nitrogen oxides, and volatile organic compounds. Emissions from new or modified onshore facilities directly associated with offshore activities are required to enable each affected state to make a determination of the effects on their air quality.

Plans of exploration, plans of development and production (which include some pipelines), and DOCD's have been determined by the Secretary as activities regulated under 30 CFR 250.57. These regulations provide for the following:

- All new or revised exploration, development and production plans, and DOCD's submitted on or after June 2, 1980, shall include air emissions information sufficient to make an air quality determination.

- A review is made relative to each plan submitted and the levels of expected emissions, as opposed to the exemption formulas, are outlined. There are provisions for required controls for those facilities found nonexempt by the aforementioned formulas.

- If MMS or an affected state submits information which demonstrates that emissions from an otherwise exempt facility will significantly affect any onshore area, additional information is collected and reviewed for that facility.

(d) Best Available and Safest Technology

To assure that oil and gas exploration, development, and production activities on the OCS are conducted in a safe and pollution-free manner, Section 21(b) of the OCS Lands Act, as amended, requires that all OCS technologies and operations use the best available and safest technology (BAST) which the Secretary determines to be economically feasible. Conformance to the standards, codes, and practices referenced in OCS Order Nos. 2, 5, 6, 7, and 8 is considered to be the application of BAST. These orders include requirements for state-of-the-art drilling technology, production safety systems, completion of oil and gas wells, oil spill contingency plans, pollution control equipment, and specifications for platform/structure designs. MMS conducts periodic offshore inspections, and the Rules, Orders, and Standards section continuously and systematically reviews OCS technologies to insure that the best available and safest technologies are applied to OCS operations. BAST is not required when the Secretary determines that the incremental benefits are clearly insufficient to justify increased costs; likewise, it is the responsibility of an operator on an existing operation to demonstrate why application of a new technology would not be feasible. This requirement is applicable to equipment which, if it failed, would have a significant effect on safety, health, or the environment, unless benefits clearly do not justify the cost.

(e) Pipelines

Regulations contained under 30 CFR 256 Subpart N provide procedures for the granting of and administration of rights-of-way for the transportation of minerals by pipeline through the OCS. Additional regulations may be imposed on rights-of-way grants issued by MMS for pipelines and accessory structures. OCS Order No. 9 further regulates and requires that all pipelines shall be installed and maintained to be compatible with trawling and other operations. Locations of pipelines and platforms are shown on maps produced by MMS, the National Ocean Survey (NOS), and the U.S. Geological Survey (USGS). FWS also reviews applications for operations and proposed pipeline rights-of-way that may impact biologically sensitive areas as well as those applications that indicate a crossing of coastal land and water areas. Procedures for reporting pipeline damage are discussed in detail in NTL 80-9. For additional information, see Volume 1, Sections I.B.3.b.(6) and (7) of the Final Regional EIS.

(f) Other Environmental Safety Controls

Besides its regulations, OCS Orders, and lease stipulations, MMS has two mechanisms which may be utilized to control or mitigate environmental or safety problems which may arise. NTL's may be issued which define operational problems and necessary actions for solution; e.g., the use of polychlorinated biphenyls (PCB's) is prohibited in conducting OCS operations, including operations utilizing onshore facilities for OCS production (NTL 73-3). In addition, conditions which may be necessary to provide environmental protection may be applied to any permit, right-of-use, or easement.

(4) Regional Technical Working Group

In 1979, DOI established the Outer Continental Shelf Advisory Board following the requirements of the Federal Advisory Committee Act (5 U.S.C. Appendix I). The purpose of the Board, as set out in the charter, is to provide advice to the Secretary of the Interior, the Director, and other officers of MMS in the performance of discretionary functions of the OCSLA, as amended.

The Board is made up of three elements: the Policy Committee, the Scientific Committee, and six Regional Technical Working Groups (RTWG). The Policy Committee advises the Secretary concerning discretionary functions, including all aspects of OCS exploration and development. The function of the Scientific Committee is to advise the Director on the feasibility, appropriateness, and scientific value of the Environmental Studies Program. The RTWG advises the Director on technical matters of regional concern relating to offshore minerals management.

The Gulf of Mexico RTWG is composed of State and Federal representatives, industry specialists, environmental interests, and people with special interests in the OCS. The purpose and objectives of the RTWG is to convene these various representatives of interests that may be affected by MMS's minerals leasing program, to provide a flow of information between the parties, and to advise the Director on technical matters of regional concern regarding the presale and postsale activities. The Gulf committee is primarily involved in reviewing and commenting on technical aspects of various sale activities and related documents and in reviewing proposals and plans for conducting environmental studies. In addition, the group participated in the first edition of a regional transportation plan for pipelines in 1981.

The information sought by MMS through the RTWG is primarily for use in developing scenarios, alternatives, and raising issues in EIS's, as well as recommending specific regional environmental studies. Potential difficulties can often be resolved early in the sale process. The opportunity exists for discussions and exchanges of technical information.

The Gulf of Mexico RTWG held its first meeting in October 1979, has been actively involved in carrying out various program objectives, and has participated in the following presale activities for proposed OCS sales in 1987:

October 21, 1985 - New Orleans, LA	The RTWG meeting included discussions on the following topics: current lease status and recent developments in the Gulf of Mexico region; the Environmental Studies Program at MMS; a 4-member panel discussion on aspects of the Gulf Ocean Incineration Program; the size of EIS's; the biological stipulations; deepwater technology; and the transportation stipulation. A summary of this meeting is given in Section V.B.

4. Other Federal Agency Regulatory/Administrative Measures

a. Navigation

Responsibilities for regulating navigation on the OCS are shared by USCG, the Federal Aviation Administration (FAA), COE, and MMS. A detailed description of these responsibilities may be found in Section I.B.4.a. of Final EIS 81/84. The Ports and Waterways Safety Act (PWSA) (33 U.S.C. 1221) provides for necessary fairways and traffic separation schemes for vessels operating offshore and recognizes, with some limitations within fairways, the paramount right of navigation over all other uses. The PWSA requires that the USCG consult with DOI to reconcile the need for safe access routes with the needs of all other reasonable uses of the area involved. Responsibility for permitting mobile drilling units (MODU's), fixed structures, and pipelines are covered by the nationwide COE permit program provision (33 CFR 330.5(a)(8)). On October 5, 1984, COE published the final rule on "Regulations for Controlling Certain Activities in Waters of the U.S." in the Federal Register (49 FR 39478). The major affect of the new rule is to establish reporting requirements and procedures.

The lease blocks and parts of blocks that lie within fairways are subject to certain constraints. Although oil and gas resources can be exploited through directional drilling, no structure may be placed in a fairway. These constraints also apply to the safety zone, fairways, and anchorage of the Louisiana Offshore Oil Port (LOOP). Lessees are advised that the USCG map designate necessary fairways through leased blocks in accordance with the Ports and Waterways Safety Act.

b. OCS Pipelines

Regulatory processes and jurisdictional limitations concerning pipelines on the OCS and in coastal areas are shared by several Federal agencies (DOI, DOT, FERC, COE, and USCG) as shown in Volume 1, Section I.B.4.b. of the Final Regional EIS. Aside from pipeline regulations, these agencies have the responsibility of overseeing and regulating the following areas: the placement of structures on the OCS and pipelines in areas that affect navigation; the certification of proposed projects involving the transportation or sale of interstate natural gas, including OCS gas; the right of eminent domain exercised by pipeline companies; and wellhead pricing controls for certain gas produced on the OCS. In addition, the Materials Transportation Bureau is responsible for promulgating and enforcing safety regulations for the transportation in or affecting interstate commerce of natural gas, liquefied natural gas (LNG), and hazardous liquids by pipeline. This includes all offshore pipelines on State lands beneath navigable waters and on the OCS. The regulations are contained in 49 CFR 191-193 and 195.

There is a Memorandum of Understanding (MOU) between the Department of Transportation (DOT) and DOI which gives recognition to each party's respective regulatory responsibilities. Basically, DOT is responsible for establishing and enforcing design, construction, operation, and maintenance regulations for pipelines extending to the shore from the outlet flange of an offshore facility. DOI responsibility extends upstream from the outlet flange.

c. Coastal Zone Management

Seven of the nine largest metropolitan areas in the United States exist within the coastal zone, and more than 50% of the population lives within 50 miles of the coastline. This has caused a diversity of increasing multiple use pressures, such as recreation, plant sitings, community development and services, and expansion of port and marine facilities. As a result of the interface between coastal resources and land use conflicts, the CZMA (16 U.S.C. 1451-1464) was enacted. The Act is administered by the Office of Ocean and Coastal Resource Management (OCRM) which was formerly named the Office of Coastal Zone Management and which is under National Ocean Service of the National Oceanic and Atmospheric Administration (NOAA) within the Department of Commerce (DOC). The CZMA sets major goals for the protection of natural, historic, and archaeological resources, and it provides for increased recreational access, the management of coastal development, and the coordination and streamlining of Federal and State decisions directly affecting the coastal resources. A Federal action directly affecting the coastal zone must be consistent with an affected coastal state's federally approved coastal management plan. If a serious consistency disagreement arises, mediation can be undertaken with the Secretary of Commerce.

The Act also provides Congress the opportunity to provide aid to the states in the form of grants. Section 305 authorizes grants for development of management programs for land and water resources in the coastal zone. Section 306 authorizes grants of not more than 80% of the program's administrative costs. Section 307 deals with interagency coordination and cooperation. A more detailed discussion of these CZMA sections has been given in Section I.B.4.c. of Final EIS 81/84.

Concern over accelerated energy exploration and development on local economies, social patterns, and the environment, particularly in coastal areas, resulted in the Coastal Energy Impact Program (CEIP), Section 308, of the CZMA Amendments of 1976. Since its establishment, CEIP has awarded millions of dollars in grants and loans to affected coastal states to prevent or mitigate the adverse impacts of OCS energy development. These grants include OCS Formula Grants, Environmental and Recreational Loss Grants, Planning Grants, and Credit Assistance. The OCSLA, as amended (P.L. 95-372), changed CEIP by adding the OCS State Participation Grant Program under the new Section 308(c)(2) of the CZMA to allow coastal states to carry out their responsibilities under the OCSLA. These grants are used for participation in policymaking, planning, and managerial decisions relating to the development of OCS oil and natural gas resources. To be eligible for a grant, a coastal state must have an approved management plan under Section 306, or, in the judgment of NOAA's Assistant Administrator, be making satisfactory progress toward the development of a management program which is consistent with Section 303 policies.

Of the four states affected by these sales, only Texas does not have an approved CZM plan. In a letter from the Governor, Texas formally withdrew from the CZM program on April 30, 1981; however, they have agencies which have the responsibility of managing the various resources, such as the Air Control Board, Parks and Wildlife, Department of Water Resources, Health Department (marine life), General Land Office (environmental protection), and the Railroad Commission (regulation of oil and gas activities).

No new CEIP funds were allocated by Congress for FY 85. Mississippi received re-programmed grants under Section 308(B) of $182,000. These grants were from allocations made prior to FY 82.

d. Archaeological Resources Legislation

The Federal Government's involvement in archaeological resource management and protection on the OCS is based on the requirements of the National Historic Preservation Act of 1966, as amended, which states, in effect, that any Federal agency, prior to approving Federally permitted or Federally funded undertakings, must take into consideration the effect of that undertaking on any property listed on, or eligible for, the National Register of Historic Places. Implied in this legislation and Executive Order 11593 is that an effort be made to locate such sites prior to development of an area. Section 11(g)(3) of the OCSLA, as amended, states that "such exploration (oil and gas) will not . . . disturb any site, structure, or object of historical or archaeological significance."

e. Endangered Species Act of 1973

The Endangered Species Act of 1973 (16 U.S.C. 1531-1543, 50 CFR 17), as amended, is administered by FWS and the NMFS, and it establishes a national policy designed to protect and conserve endangered and threatened species and the ecosystem upon which they depend. Section 7 of the Act, governing interagency cooperation, requires Federal agencies to consult with FWS and NMFS to ensure that their actions do not jeopardize the continued existence of an endangered or threatened species and/or result in adverse modification or destruction of their critical habitat.

f. Marine Mammal Protection Act of 1972

The Marine Mammal Protection Act of 1972 [16 U.S.C. 1361-1407, 86 Stat. 1027 (1972), 95 Stat. 979 (1981)], as amended, establishes a national policy designed to protect and conserve marine mammals and their habitats. Authority for administering the Act has been delegated to the NMFS, which is responsible for all cetaceans and pinnipeds (except walrus), and FWS, which is responsible for walrus, sea otters, manatees, and dugongs. The Act specifically prohibits the harassing, hunting, capturing, or killing of any marine mammal unless otherwise exempted under provisions of the Act. The Marine Mammal Commission is responsible for advising Federal agencies on the protection and conservation of marine mammals. The Commission has a Committee of Scientific Advisors which provides advice on actions needed to fulfill the purposes of the Act.

g. Fishery Conservation and Management Act of 1976

The Fishery Conservation and Management Act of 1976 (FCMA) (16 U.S.C. 1801-1882) established a fisheries conservation zone off the coasts of the United States and its possessions from the states' seaward boundary to a line that is 200 nmi from the baseline from which the territorial sea is measured. The Act created eight Regional Fisheries Management Councils and mandated a continuing planning program by the Councils. As a part of this program, a Fishery Management Plan (FMP) must be prepared for each species (or related group of species) of fish harvested within each respective region.

The Act, as amended, requires that a FMP based upon the best available scientific and economic data be prepared for only those species (or related group of species) of fish harvested within each respective region that is in need of conservation and management.

The FMP for shrimp was implemented in May 1981; the FMP for stone crab was implemented in March 1982; the FMP for spiny lobster was implemented in April 1982; the FMP for coastal pelagics was implemented in February 1983; the FMP for coral was implemented in August 1984; the FMP for reef fish was implemented in November 1984; and the FMP for swordfish was implemented in September 1985.

The shrimp plan includes a seasonal closure off the coast of Texas which will run from about June 1-July 15 each year to allow for a longer period of growth for the shrimp. Under the shrimp plan, it is estimated that the cooperative closure of State and Federal waters off the coast of Texas produced increases of 9.8, 4.9, and 3.5 million pounds of shrimp in 1981, 1982, and 1983, respectively. Also, the plan provides for a permanent closure of the Tortugas shrimp nursery off Florida.

For a more detailed description of the Fishery Conservation and Management Act of 1976, see Volume 1, Section I.B.4.g. of the Final Regional EIS.

h. Maritime Boundary

The Treaty on Maritime Boundaries between the United States and the United Mexican States was signed on May 4, 1978, and is awaiting Senate advice and consent to ratification. In the meantime, the United States and Mexico are applying the boundary lines provisionally, pursuant to an exchange of notes on November 24, 1976. Although the area of analysis straddles the boundary in places, only submerged lands north of that boundary can be offered for lease. The 123 blocks immediately adjacent to the boundary have been deferred from proposed Sale 112 as shown on Figure I-1.

i. National Fishing Enhancement Act of 1984

Title II of Public Law 98-623, also known as the Artificial Reef Act, establishes a National policy of the United States to encourage the development of artificial reefs which will enhance fishery resources and commercial and recreational fishing. The Secretary of Commerce is directed to take the lead in developing National standards and a National Artificial Reef Plan that identifies design, construction, siting, and maintenance criteria for artificial reefs, and to provide a synopsis of existing information and future research needs on artificial reefs. The Secretary of the Army will issue permits to responsible applicants for reef development projects in accordance with the National standards and plan, as well as regional and local criteria and plans. The new law also limits liability of reef developers complying with permit requirements and amends the Reefs for Marine Life Conservation Law to include the availability of all surplus Federal ships for consideration as reef development materials. Although the Act mentions no specific materials other than ships for use in reef development projects, the Secretary of the Interior is required to cooperate with the Secretary of Commerce in developing the National plan. The Secretary of the Interior has already taken several initiatives in support of this National policy by creating the Recreational and Environmental Enhancement and Fishing in Seas (REEFS) task force and is cooperating with ocean industries through MMS in developing a Rigs-to-Reefs policy and program.

j. Executive Order 11990, Protection of Wetlands

Executive Order 11990, Protection of Wetlands (May 24, 1977), is pertinent to the proposed action as it states in part:

> "Each agency shall provide leadership and shall take action to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands in carrying out the agency's responsibilities for . . . conducting Federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulating and licensing activities. This Order does not apply to the issuance by Federal agencies of permits, licenses, or allocations to private parties for activities involving wetlands on non-Federal property."

This Order would apply to two National Parks and eight National Wildlife Refuges in the Central and Western Gulf region.

k. Ports and Waterways Safety Act

The Ports and Waterways Safety Act authorizes the Coast Guard to designate necessary fairways and traffic separation schemes (TSS) to allow vessels unobstructed, safe access to U.S. ports. Safety fairways are areas in which no fixed structures are permitted, and therefore may inhibit exploration and exploitation of mineral resources in the area so designated. Fairways may be viewed as a necessary compromise between convenient mineral exploitation and concern for navigation safety. TSS's are designed to increase navigation safety by separating opposing lanes of vessel traffic. In order to ensure that the interest of all affected parties are considered, the Act mandates that a port access route study be conducted when new fairway areas of TSS's are contemplated. Publication of a study notice advises all bidders in future lease sales within the study area that occupancy rights may be restricted by a routing system developed as a result of the study. Where resources are known to exist beneath fairways and TSS's and access is limited and also where navigable area is available, the Coast Guard will study the alternatives for relocating an existing fairway or TSS.

5. Regulations Governing Oil Spills, Petroleum Effluents, and Other Discharges

The Federal Water Pollution Control Act of 1972 (33 U.S.C. 1251 et seq.) (FWPCA), as amended, and commonly called the Clean Water Act, provides a major tool to the Federal Government to ensure that the chemical, physical, and biological integrity of the Nation's waters are maintained. It provides a comprehensive plan for dealing with oil spills and discharges of oil and oil-containing substances into Gulf waters in connection with activities under the OCSLA, as amended. The FWPCA addresses prevention and control of spills, response to and removal of spilled oil, and for the determination of liability and compensation for damage resulting from spills. These aspects of the FWPCA are discussed in Volume 1, Sections I.B.5.a.(1), b., and c.(1) and (2) of the Final Regional EIS.

Other important acts under which regulations have been promulgated to minimize pollution incidents and the potential environmental and economic damage caused by the release of pollutants from various sources to Gulf waters include the OCSLA, as amended, the Ports and Waterways Safety Act, and the Comprehensive Environmental Compensation and Liability Act (CERCLA), or "Superfund." Other acts which exert a lesser influence due to their restricted applicability in the Gulf include the Deep Water Port Act of 1974 and the Trans-Alaskan Pipeline Authorization Act. The Clean Air Act provides for regulations controlling air emissions from shorebased OCS-related facilities. The legal mandates and regulations relative to pollution control established by these Federal statutes, along with the administering Federal departments and agencies, are detailed in the Final Regional EIS.

Except for the changes or updated material described below, the information provided in Volume 1, Sections I.B.5.a.-d. of the Final Regional EIS, Section I.B.5. of Final EIS 81/84, and Section I.B.5. of Final EIS 94/98/102 is correct.

National Pollution Discharge Elimination System (NPDES)

USEPA Regions IV and VI, which have regulatory authority in the Gulf of Mexico, are in the process of developing effluent guidelines for discharges from offshore oil and gas extraction operations and developing a more comprehensive evaluation of the effects of these discharges on the marine environment. The development of these guidelines and additional information on the effects of the discharges will enable the Agency to propose and issue 5-year term general permits for actions submitted after October 26, 1984. Pending issuance of the general 5-year permit, the existing three general permits for the Central and Western Gulf, which expired on April 29, 1983, had been reissued as of October 17, 1983, (48 FR 41494) but expired June 30, 1984. The Public Notice of the Draft General NPDES Permits for Oil and Gas Operations in Portions of the Gulf of Mexico appeared in the *Federal Register* on April 4, 1983 (48 FR 14440), and the deadline for comments closed May 16, 1983. The final rule for the NPDES permit program was published in the *Federal Register* on September 26, 1984. On July 26, 1985, USEPA published in the *Federal Register* (50 FR 30564) the public notice of the Draft General Permits which will establish effluent limitations, prohibitions, and other conditions on discharges from oil and gas facilities for the Point Source Category. The deadline for comments closed October 7, 1985.

Ocean Dumping Program

USEPA is responsible for issuing permits for ocean dumping. All ocean dumping is regulated by the Marine Protection, Research, and Sanctuaries Act of 1972, as amended (33 U.S.C. 1401). USEPA has designated and approved an ocean dumping site for the dumping of dredged material in the Gulf of Mexico offshore Galveston Harbor. The location of the disposal site is approximately 3.7 nmi southeast of Galveston Island and occupies an area of approximately 6.6 nmi2. This information was published in the *Federal Register* on August 31, 1984 (49 FR 34485), and became effective October 1, 1984. For a more detailed discussion on ocean dumping, see Section I.B.6.e.

Ocean Incineration

USEPA regulates ocean incineration under the authority of the Marine Protection, Research and Sanctuaries Act of 1972 (33 U.S.C. 1401). In 1974, USEPA included ocean incineration as part of ocean dumping. There is currently a designated ocean dumping site for incineration of toxic wastes in the Western Gulf. On February 28, 1985, USEPA published the public notice for ocean incineration which modified the ocean dumping regulations that govern incineration permits and incineration sites (50 FR 8222). For a more detailed discussion on ocean incineration, see Section I.B.6.f.

Minerals Management Service and U.S. Coast Guard Surveillance Patrols

MMS is currently considering a plan to incorporate the OCS Orders into regulation 30 CFR 250. Presently, under OCS Order No. 9.E., MMS receives annual inspection reports which are furnished by pipeline operators. The operators are required to maintain pipelines in good operating condition at all times and to inspect them on a monthly basis for an indication of leakage using aircraft, floating equipment, or other methods. Records of these inspections include inspection dates, methods utilized, and the results of each inspection. The USCG conducts weekly MARPOL 73/78 surveillance overflights (See Section I.B.5. of Final EIS 81/84, International Measures, for a discussion of MARPOL). These patrol areas are broken down by zones based on the amount of vessel traffic: Miami to Key West (four flights weekly); Melborne to Miami (three flights weekly); and Mobile to Port Arthur (one flight weekly). Patrols concentrate surveillance from 12-50 miles offshore in each of the coverage areas with 10% of the flights devoted to patrols from 50-100 miles offshore.

Department of Transportation's Prevention Program

The U.S. Coast Guard has the responsibility for pollution prevention of the Nation's navigable waters. When this prevention proves impossible, they bear the responsibility of identifying, controlling, and cleaning up the oil or other contaminants which pollute United States' waters, except when MMS's authority over OCS oil and gas exploration activities supersedes their authority.

Section 4 of the OCSLA grants authority to USCG to promulgate and enforce regulations covering lighting and warning devices, safety equipment, and other safety-related matters pertaining to life and property on fixed OCS platforms and drilling vessels. New requirements for cargo lightering operations were published in the *Federal Register* on March 26, 1984. This final rule establishes regulations for the lightering of oil and hazardous material cargoes in bulk from one vessel to another in the marine environment surrounding the U.S. Certificates of Inspection, or for foreign vessels, a Certificate of Compliance, must comply with MARPOL 73/78.

33 CFR 1 and 153 were revised and published in the *Federal Register* on January 5, 1984. This rule delegates authority to USCG officials to perform pollution response functions under CERCLA.

33 CFR 140-147 provide the USCG with requirements for safety equipment and other matters relating to safety promotion of life and property on the artificial islands and fixed structures located on the OCS, as established in Section 4(c)(1) of the OCSLA.

The Public Notice of the Reception Facilities requirement of the International Convention for the Prevention of Pollution from Ships, 1973, as modified by MARPOL 73/78 was published in the *Federal Register* on June 19, 1984. The proposed regulation provides criteria for determining the adequacy of reception facilities and for administrative procedures for granting Certificates of Adequacy to ports and terminals. The deadline for comments closed August 20, 1984.

On September 9, 1985, the interim rule on reception facilities appeared in the *Federal Register* (50 FR 36768). The proposed rule goes into effect March 10, 1986, and the final due date for comments was December 9, 1985. USCG also published a proposed rule on September 20, 1985, for the Oil and Hazardous Substance Discharge Reporting Requirements. This proposal modifies the procedures for reporting discharges of oil and hazardous substances as required by Section 311 of the Federal Water Pollution Control Act, as amended (FWPCA), and revises, deletes, and clarifies the language and the criteria for direct payment to the Pollution Fund. The comments were due November 19, 1985.

Department of the Interior's Prevention Programs

The MMS, Gulf of Mexico OCS Region, monitors all activities affecting safety and pollution prevention in marine oil and gas operations in the Gulf and develops and ensures OCS standards for safety and pollution control equipment and procedures. The MMS OCS Orders are being revised and there currently is a plan to incorporate the OCS Orders into regulation 30 CFR 250.

OCS Order No. 7 provides the major specifications for preventing and controlling pollution of the environments (Section I.B.3.b.(1)(f)).

OCS Order Nos. 2, 5, and 8, with their references to the American Petroleum Institute's Recommended Practices and Standards, contain guidelines for assuring safe operations.

Regulations applicable to the BAST program, 30 CFR 250.34(a)(1) and 30 CFR 250.34-2(a)(1)(ii), (v), and (vi), require that special attention be directed to safety and pollution prevention and control features, including oil spill cleanup and containment provisions, in all exploration plans and in all development and production plans. They also describe the safety standards and features and environmental safeguards that will be employed during development and production operations.

Response Measures

The development of contingency guidelines that serve as mechanisms for coordinating an effective response to oil spills is currently being developed and addressed at all levels of government and private industry. As described in the Final Regional EIS, the State of Florida has a coastal pollutant spill contingency plan. This plan was recently updated in July 1984. In addition, the State of Texas has developed an "Oil and Hazardous Substances Pollution Contingency Plan." The Mississippi Bureau of Marine Resources has prepared a Contingency Plan for the Mississippi coastal area which is expected to be published in November 1985. Presently, Alabama does not have a contingency plan, but the information in a report entitled "Sensitivity of Alabama Shoreline Habitats to Spilled Hydrocarbons" (available from the Geological Survey of Alabama) assists the State in contingency planning and decisionmaking. This report addresses the ecological sensitivity of natural shoreline habitats to spilled hydrocarbons.

The State of Louisiana does not have a formal written contingency plan; however, the Department of Environmental Quality is developing a set of criteria which defines and establishes a process for notification in the event of a spill. The Department of Environmental Quality represents the State's Regional Response Team (RRT) and coordinates with USCG, USEPA, state police, the State Department of Fish and Wildlife, and the State Department of Health. As of this writing, there are no plans to develop a state contingency plan for Louisiana.

OCS Order No. 7

OCS Order No. 7 requires the operator to submit an oil spill contingency plan to MMS prior to approval of permit application for conducting operations with this plan being reviewed on an annual basis.

The plan must contain assurances that a full response capability is known and can be committed during an oil spill situation. Since a commitment includes specification of appropriate equipment and materials, their availability, and deployment time, it must also include provisions for varying degrees of response effort, depending on the severity of the discharge. Provisions must be established for early detection and timely notification of a spill to the responsible agencies and persons, as well as specific response actions. These provisions include identification of a trained, prepared, and available response operating team, predesignation of an oil discharge response coordinator, preplanned location for an oil discharge response operations center, and provisions for disposal of recovered material. The plan must also demonstrate a knowledge of, and strategy for, protecting areas of special biological sensitivity. This OCS Order is presently being revised and the finalization of this Order is expected in November 1986.

National Contingency Plan, as amended, by CERCLA

The revised National Oil and Hazardous Substance Contingency Plan (NCP) was published in the *Federal Register* on March 13, 1982, and went into effect on December 10, 1982. The final revised NCP allows on-scene coordinators (OSC) to authorize the use of dispersants in oil spill cleanups, but only if these dispersants appear on the dispersant acceptance list. The dispersant acceptance list included 28 products tested and accepted under procedures described in the 1981 NCP. For a more detailed discussion of dispersants, see Appendix D of Final EIS 104/105. USEPA has modified a section of proposed Subpart E to differentiate the oil spill cleanup activities for which Federal funds are available under Section 311(k) of the Clean Water Act, the Deepwater Port Act, the OCSLA, and the Trans-Alaskan Pipeline Authorization Act. Revised Subpart G, which designates the agencies that will act as trustees of natural resources lost or damaged following a spill, now includes a section designating states as trustees of the natural resources located within their borders. In addition, this revision incorporates a provision for DOI and DOC to act as co-trustees of resources falling under the jurisdiction of both Federal agencies. A Memorandum of Understanding (MOU) specifies the trusteeship responsibilities of each agency in areas where a pollution incident could affect the natural resources under the authority of both DOI and DOC.

Subpart H, published in the *Federal Register* on July 18, 1984, allows the OSC, with the concurrence of the USEPA representative to the RRT and the concurrence of the states with jurisdiction over the navigable waters polluted by the oil discharge, to authorize the use of dispersants, surface collecting agents, and biological additives on the oil discharge, provided that the dispersants, surface collecting agents, or additives are on the NCP Product Schedule. However, the OSC may use a product not on the NCP Product Schedule without obtaining the concurrence of the USEPA representative to the RRT of the states when, in the judgment of the OSC, the use of the product is necessary to prevent or substantially reduce a hazard to human life. Afterwards, the OSC is to inform the USEPA RRT representative and the affected states of the use of a product as soon as possible and obtain their concurrence for its continued use once the threat to human life has subsided.

International Measures

A meeting was held by experts from 17 island states and territories of the wider Caribbean in St. Lucia to consider and adopt a subregional Oil Spill Contingency Plan for the Caribbean Islands. The plan addresses policy and responsibility, response operations including requests for assistance, joint response operations, and the use of dispersants; reporting and communications; and administration and logistics.

On July 24, 1980, the Agreement of Cooperation Between the United States of America and the United Mexican States Regarding Pollution of the Marine Environment by Discharges of Hydrocarbons and Other Hazardous Substances was signed. The agreement concerns the joint response of the United States and Mexico to oil spills and spills of other hazardous polluting substances which have the potential for affecting both states or where one state requests the assistance of the other state. The agreement provides for the designation of on-scene coordinators, a joint response team, an on-scene liaison, and advisory officers. The on-scene coordinators are the U.S. Coast Guard and the Mexican Navy. The agreement outlines in detail the duties and responsibilities of the on-scene coordinators and joint response team. It provides for the establishment of joint response centers, a rapid system of notification, and follow-up reports.

It is believed that similar plans will be adopted for the Central American and South American parts of the wider Caribbean Region.

6. Interrelationship with Other Programs and Proposals

a. Estuarine and Marine Sanctuaries

The Estuarine and Marine Sanctuary programs are discussed in Volume 1, Section I.B.6.a. of the Final Regional EIS. Few changes to the program have taken place since the writing of the Final Regional EIS. See also Section I.B.6.a. of Final EIS 81/84.

Two estuarine sanctuaries, both in Florida, have been established in the Gulf of Mexico: Rookery Bay Estuarine Sanctuary and Apalachicola Bay and River Estuarine Sanctuary. No marine sanctuaries have been established in the Gulf of Mexico; however, two are located on the Atlantic side of the Florida Keys: Looe Key National Marine Sanctuary and Key Largo Reef Marine Sanctuary.

Both estuarine and marine sanctuaries are designed and managed to meet the following goals, among others:

(1) enhance resource protection through the implementation of a comprehensive, long-term management plan tailored to the specific resources;

(2) promote and coordinate research to expand scientific knowledge of significant marine resources and improve management decisionmaking;

(3) enhance public awareness, understanding, and wise use of the marine environment through public interpretive and recreational programs; and

(4) provide for optimum compatible public and private use of special marine areas.

Only sites with special marine resources are selected for marine sanctuary status. Sites selected for consideration are evaluated on the merits of resource and human use values and on the public benefits to be derived from sanctuary status.

Under the Program Development Plan of January 1982 (described in the Final Regional EIS), NOAA established a number of Regional Resource Evaluation Teams, each to recommend "3 to 5" appropriate sites for consideration as marine sanctuaries. The Gulf of Mexico Team recommended several sites. Of these, four were selected to be placed on the Site Evaluation List (SEL) to receive further study and consideration. (The final SEL was published in 48 FR 35568-35577 on August 4, 1983.) Listing a site on the SEL does not mean that the site is a proposed sanctuary or that it will necessarily be considered as an active candidate for sanctuary designation. However, with few exceptions NOAA will only consider those sites on the SEL for further review as active candidates for marine sanctuary designation. Sites listed on the SEL that have not been reviewed for active candidate status after 5 years will be reevaluated.

Of the four sites placed on the SEL for the Gulf of Mexico, one (the Flower Garden Banks) has been designated an Active Candidate. The Shoalwater Bay-Chandeleur Sound, Louisiana, site is located in the Central Gulf of Mexico, encompassing approximately 80 mi2 of State waters including seagrass beds and algae. The Baffin Bay, Texas, site in the Western Gulf of Mexico is a bay-estuary system separated from the Gulf by a barrier island. The fourth site is the Big Bend Seagrass Beds in the Eastern Gulf of Mexico.

Recently, the Flower Garden Banks were named an Active Candidate for designation as a national marine sanctuary (49 FR 30988-30991 of August 2, 1984). Selection of the site as an Active Candidate formally triggers the National Environmental Policy Act process. NOAA is preparing a draft management plan and a draft environmental impact statement.

This site, located 110 mi (177 km) offshore, represents the northernmost coral reef community in the Western Gulf of Mexico. The proposed borders of the sanctuary encompass a total of 44 mi2 (114 km2). The area is a valuable representation of a tropical coral reef community dominated by hermatypic coral (*Montastrea annularis, M. cavernosa, Porites asteroides*, and *Diploria strigosa*) and associated reef fishes and invertebrates. DOI has protected the biological resources of the Flower Gardens from possible damage due to oil and gas exploration and development activities by the establishment of a "No Activity Zone" and operational restrictions. (See the appropriate subsections of Section II and especially Figures I-3 and I-4.) DOI cannot, however, protect these reefs from damage due to activities outside DOI's permitting process. The Gulf of Mexico Fishery Management Council, in its proposed Fishery Management Plan for corals, has designated the area within the 50 fathom (91.4 m) isobath at the Flower Gardens as a Habitat Area of Particular Concern (HAPC) (50 CFR 638), but even with such designation the Council is unable to regulate "nonfishing" activities such as anchoring of ships. MMS, therefore, supports designation of the reefs as a marine sanctuary in order to protect the reefs from non-oil and gas-related activities, such as anchoring (which has been shown to be the most destructive of man's activities in the area), the use of heavy trawls (such as roller trawls), and the taking of corals and reef fishes.

b. Deepwater Ports

The Deepwater Port Act of 1974 (33 U.S.C. 1501) gives DOT the authority to license deepwater ports. The purpose of a deepwater port is to provide offshore terminal facilities for importation of oil, via pipelines, from tankers too large for conventional ports (primarily supertankers) and to avoid the need for lightering. Presently, in the Gulf, LOOP is the only such port in operation. It is located in 115 ft of water in Grand Isle Block 59, approximately 19 miles from shore. Vessel access to LOOP is by means of the designated fairway, anchorage, and safety zone (Figure I-4 of the Final Regional EIS). No mobile drilling operations or installation of permanent structures may take place in these areas. The North of Gulf and South of Gulf fairways, associated with LOOP, have recently been incorporated into Part 166, Shipping Safety Fairways. This information was published in the *Federal Register* on July 1, 1985 (50 FR 28989).

On August 15, 1985, DOT published in the *Federal Register* (50 FR 32966); the final rule for "Deepwater Port Liability Fund." Part 137 was added to Title 33 and establishes procedures for payment of fees to the Fund, settlement of claims, vessel owner/operator financial responsibility, and notification of spill under the deepwater Port Act of 1974.

c. Ocean Thermal Energy Conversion

Ocean thermal energy conversion (OTEC) is a process which utilizes the temperature differences between deep, cold seawater and relative warm surface water to drive a heat engine for the generation of electricity. Thus far, OTEC and offshore oil and gas operations have never been in conflict; however, the Gulf is a prime candidate for OTEC operations primarily due to its large temperature differentials and close proximity to the continental United States. If an OTEC plant is ever established in a developed oil and gas area such as the Gulf, impacts will probably be limited to increased navigational problems and environmental implications inherent to the OTEC process. For more information on this subject, see Section I.B.6.c. of Final EIS 81/84.

d. Offshore Mining

The Secretary of the Interior is authorized under the OCSLA to issue leases for minerals other than oil, gas, and sulfur on the OCS. The Secretary is further supported by federally legislated policy to foster and encourage private enterprise involvement in mining or mineral activities (Mining and Minerals Policy Act of 1955, P.L. 83-217); to foster and encourage private enterprise in the development, reclamation, recycling, and wise disposal of domestic mineral resources (Mining and Minerals Policy Act of 1970, P.L. 91-631); and to encourage Federal agencies to facilitate availability and development of domestic resources to meet critical material needs (The National Materials and Minerals Policy Research and Development Act of 1980). While commercially exploitable mineral commodities are potentially available as surficial or near surficial deposits on the OCS, onshore supplies and an unfavorable economic climate have precluded their development. Recently, a unit sulphur development operations coordination document has been filed with MMS for proposed mining operation in Grand Isle Blocks 16, 17, 22, and 23. Prerequisites for future development are the evaluation of the quality and quantity of the resources, followed by technological advances and a supportive economic climate. For a more detailed discussion of offshore mining, see Volume 1, Section I.B.6.d. of the Final Regional EIS.

e. Ocean Dumping

All ocean dumping is regulated by the Marine Protection, Research, and Sanctuaries Act of 1972 (MPRSA), as amended (33 U.S.C. 1401 et seq.). Regulations (40 CFR 220 et seq.) implementing the Act require a USEPA permit for all ocean dumping of industrial wastes and municipal sludge materials. 33 U.S.C. 1412a mandates the termination of ocean dumping of sewage sludge and industrial wastes by December 31, 1981. 40 CFR 228 lists the designated ocean areas where wastes may be disposed. Further, USEPA has published an annual report entitled "Ocean Dumping in the United States." This report includes information on permit holders, type of waste approved for disposal under the permit, and yearly waste volumes disposed. USEPA has one designated deepwater disposal area in the Gulf of Mexico, as shown on Visual No. 3. The site is designated for the incineration of hazardous wastes. Refer to Section I.B.6.f. for further information concerning this site.

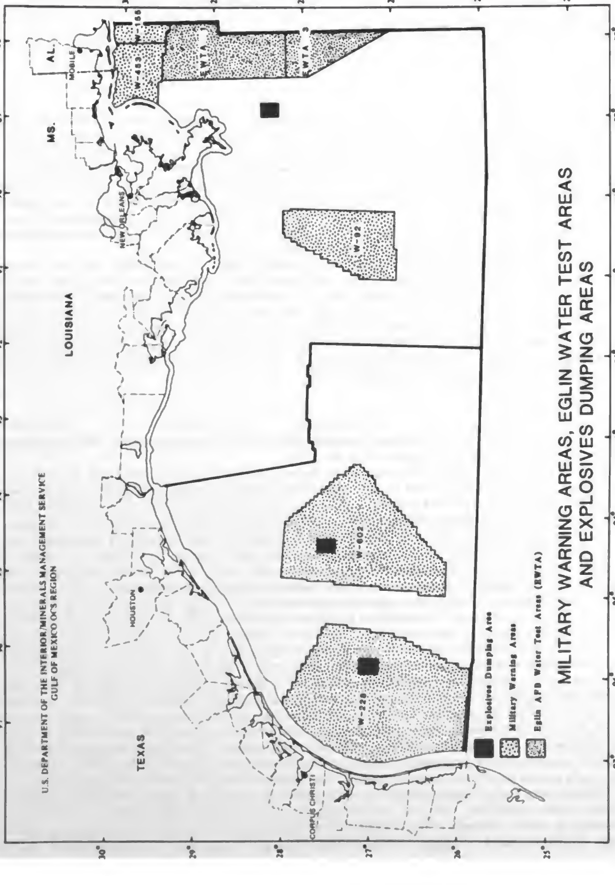
The Department of Defense's (DOD) explosives dumping areas found in the Gulf planning areas are shown on Figure I-5. Most of the small areas contain a single, undetonated depth charge. For the eight large areas shown, dumping consisted of old ordnance and unexploded (duds) shells and depth charges. No dumping has taken place in any explosive areas since 1969-1970. However, all lessees should take precautions in drilling and locating structures within or near these areas due to the presence of unexploded ordnance. The U.S. Air Force (USAF) has released an indeterminable amount of unexploded ordnance in water test areas 1-5 as a result of testing and training missions. The exact locations of this unexploded ordnance cannot be determined and all lessess in the Gulf should take precautions in drilling or locating structures in these areas.

f. Ocean Incineration

There is one ocean dumping site designated for the incineration of organohalogen wastes in the Gulf of Mexico. This site, shown on Visual No. 3 and Figure I-2, is in the WPA.

The USEPA regulates ocean incineration under the authority of the Marine Protection, Research, and Sanctuaries Act of 1972 (33 U.S.C. 1401 et seq). The MPRSA prohibits the ocean dumping of wastes without a permit. The MRPSA authorizes the Administrator of USEPA to designate ocean dumping sites (33 U.S.C. 1412c). In designating a site, the Administrator must consider the following criteria: (1) the need for the proposed dumping; (2) the effect of such dumping on human health and welfare, including economic, aesthetic, and recreational values; (3) the effect of such dumping on fisheries resources, plankton, fish, shellfish, wildlife, shorelines, and beaches; (4) the effect of such dumping on marine ecosystems, particularly with respect to (a) the transfer, concentration, and dispersion of such material and its byproducts through biological, physical, and chemical processes, (b) potential changes in marine ecosystem diversity, productivity, and stability, and (c) species and community population dynamics; (5) the persistence and permanence of the effects of the dumping; (6) the effect of dumping particular volumes and concentrations of such materials; (7) appropriate locations and methods of disposal of recycling, including land-based alternatives and the probable impact of requiring use of such alternate locations or methods upon considerations affecting the public interest; (8) the effect on alternate uses of oceans, such as scientific study, fishing, and other living resource exploitation, and nonliving resource exploitation; and (9) in designating recommended sites, the Administrator shall utilize, wherever feasible, locations beyond the edge of the continental shelf. In 1976, USEPA designated the Western Gulf ocean dumping site for the incineration of toxic wastes (41 FR 39319). This site was designated for a period of five years. Only one ship was permitted to burn at a time, except under extreme emergencies. In 1982, USEPA redesignated the ocean disposal site for continuing use (47 FR 17817). Except for transferring the management of the site to USEPA headquarters, the conditions of the use of the site remained the same as the 1976 designation. The Gulf Ocean Incineration Site is described in 40 CFR 228.12.b.1.

There has been limited burning in the Gulf. During 1974 and 1975, Shell conducted two research and two operational burns in the Gulf. This was the first United States use of ocean incineration for the disposal of organochlorine wastes. Between 1974 and 1982 USEPA issued permits for three series of burns in the Gulf of Mexico. USEPA has developed proposed ocean incineration regulations based on the experience of these burns (50



MILITARY WARNING AREAS, EGLIN WATER TEST AREAS AND EXPLOSIVES DUMPING AREAS

Figure I-5

FR 8222). All future burns will require a USEPA permit. No permit applications will be reviewed until promulgation of the final ocean incineration regulations. For discussion of possible conflicts between OCS activity and ocean incineration, see Section II.B.1.e.(1).

In order to inform lessees of the potential conflict in use and the potential hazards, information on the Gulf Ocean Incineration Site is proposed for inclusion in the Notice of Sale. Lessees would be informed of the location of the site and advised to coordinate the timing of their drilling operations with USEPA. Coordination between MMS and USEPA is ongoing in order to develop procedures which will ensure the safe use of the area.

g. Dredge Material

The dredge is used exclusively for excavation in water. It is used to deepen channels, ports, and harbors and to provide fill material for construction of piers, wharves, docks, underwater foundations, dikes, levees, and related water management structures. Dredging occurs to maintain open channels, canals, and waterways and for the excavation of sand, shell, gravel, and other minerals. Permits issued by COE are required for work on structures in navigable waters of the United States, for the discharge of dredged material or fill into navigable waters, and for transportation of dredged material for the purpose of dumping into ocean waters. COE exercises regulatory authority in navigable waters primarily under the Rivers and Harbors Act of 1899 and the Federal Water Pollution Control Act of 1972. Dredge and fill regulations were revised in July 1975 to include nontidal wetlands. Permits are required by State and local governments, private operators, and other Federal agencies including COE. Permit applications are evaluated to determine the benefits and/or detriments resulting from a proposed action. A permit is issued when it is determined by COE that the proposal is in the overall public interest.

h. National Defense

The U.S. Navy and Air Force actively use nine military warning areas and five water test areas in the Gulf of Mexico, as shown on Visual No. 11 and Figure I-5. Five of these warning areas lie in the CPA and WPA, and four of these warning areas and the five water test areas lie in the Eastern Gulf. Military operations within these warning areas vary in the types of missions performed and their frequency of use. Such missions include carrier maneuvers, missile testing, rocket firing, pilot training, air-to-air gunnery, air-to-surface gunnery, minesweeping operations, submarine operations, air combat maneuvers, aerobatic training, missile testing and development, and instrument training.

In the CPA, WPA, and Eastern Gulf, space-use conflicts will develop with increased USAF and Navy testing and training activities and unrestricted oil and gas development crucial to the Nation's economic and military security. DOI and DOD will work together to assure that Federal offshore development does not conflict with military training. Consultation will take place early and often in the two-year process leading to a lease sale to avoid conflicts and restrictions to the objectives of both departments.

Other general site-specific stipulations have been developed, as necessary, to avoid conflicts and, in irreconcilable cases, areas will be deferred from lease sales.

i. OCS Geothermal

The petroleum crisis of 1973 caused an awakening in many countries for the need to evaluate and develop alternative energy sources. Consequently, during the past 10 years, geothermal exploration, utilization, and research have taken a dramatic upswing, both in the United States and throughout the world. This upswing in the United States has resulted in new information, improved exploration, extraction, and utilization technologies, and a greater understanding of resource characteristics.

Of the four categories of geothermal systems recognized, technology has not been developed to utilize the first two types which include magnetic and hot, dry rock systems. The third type, convective geothermal, is the only type now being commercially exploited. In convection systems, circulating fluids within a bounded reservoir transfer heat from a deep source to near the surface. Isotope ratios and trace element studies indicate the source of the convective water to be primarily meteoric. Rainwater percolates downward, presumably along fault planes, becomes heated, and where impermeable rock overlies the permeable reservoir, the escape of the water is prevented and a convective system is created. The fourth type of system consists of geopressured zones, which occur throughout the world in basins where rapid sedimentation and contemporaneous faulting are taking place and are characterized by abnormally high pressures and temperatures. The most understood and studied geopressured region in the world is the Gulf coast of the United States.

Geopressured-geothermal waters along the Texas and Louisiana Gulf coast contain three forms of energy capable of utilization through existing technology. This energy may be harnessed to produce heat or electric power, as well as feedstock for the chemical industry; however, as in the conversion of most types of potential energy to readily usable forms, special problems exist requiring some development work and unique solutions. The potential for economically extracting solution methane from water is one of the most attractive aspects of the offshore geopressured-geothermal prospects. Investigation of the technical and economic viability of producing water for methane extraction upon depletion of conventional oil and gas reservoirs is suggested as an alternative to the plugging of wells and removal of production platforms. Initial processing of this energy resource may most likely develop on land, but continued future development could proceed into OCS waters. For a more detailed discussion of OCS geothermal, refer to BLM Open File Report 81-01 (USDI, BLM, 1981).

j. Strategic Petroleum Reserve

The 1973 petroleum embargo highlighted the perceived requirement for a petroleum reserve for the United States in the event of interruption of the flow of petroleum in the United States from any cause. This need was met with legislation in the Energy Policy and Conservation Act of 1975 (42 U.S.C. 6201 et seq.), which created the Strategic Petroleum Reserve (SPR), and also provided for the Early Storage Reserve, the Industrial Petroleum Reserve, and the Regional Petroleum Reserve.

The Energy Policy and Conservation Act provided for the amount of the reserve to equal the total volume of oil imported over a three consecutive month period in 1974-1975 during which average monthly import levels were highest. Based on imports in these months, the SPR Plan recommended a Reserve size of 500 million barrels (MMB). The plan stated that if subsequent estimates of national vulnerability showed a need for a larger or smaller Reserve, this requirement would be presented to the Congress as a Plan Amendment.

Based on recent vulnerability assessments, prudence dictates that this country prepare to deal with the possibility of another such interruption. Therefore, SPR Plan Amendment No. 2 increased the size of the SPR to 1,000 MMB. To date, the SPR program has been organized into three major phases consisting of: (1) Phase I which consists of development of the initial 248 MMB in existing underground capacity available at five salt domes in Texas and Louisiana; (2) Phase II consists of the 290 MMB expansion of existing underground storage capacity, increasing SPR's capacity to 538 MMB; and (3) Phase III which represents expansion of SPR storage capacity by 212 MMB to achieve a 750 MMB reserve by 1989 (US, DOE, 1981).

7. Gulf of Mexico Regional Environmental Studies Program

MMS supports and administers a large, multidisciplinary studies program to develop information needed for assessment and mitigation of impacts to marine and coastal environments which may be affected by OCS oil and gas activities. This program was initiated in 1973 with award of contracts for collection and synthesis of environmental and socioeconomic information, and was developed to include major field studies in 1974 and subsequent years. During the period of 1974-1978, the program consisted largely of baseline studies in the South Texas and Eastern Gulf of Mexico (MAFLA) areas, plus "special studies" of numerous offshore submarine banks of the Texas/Louisiana continental shelf. The baseline studies approach was abandoned in late 1978, and the program was reoriented to include a wide variety of study approaches. A detailed description of the program's history, objectives, and present composition is presented in Volume 1, Section I.B.7. of the Final Regional EIS, and in the Regional Studies Plan, Fiscal Year 1986 (USDI, MMS, 1985b); study areas for the various field studies are portrayed on Visual No. 5.

SECTION II

ALTERNATIVES INCLUDING THE PROPOSED ACTIONS

II

II. ALTERNATIVES INCLUDING THE PROPOSED ACTION

A. CENTRAL GULF SALE 110

1. Alternative A - The Proposed Action

a. Description of the Proposed Action

The proposed action for Central Gulf Sale 110 (April 1987) is to offer for lease all unleased blocks in the Central Planning Area (CPA) of the Gulf of Mexico (Figure I-1). The proposed action is consistent with DOI's objective of offering for lease promising areas of hydrocarbon potential as identified by industry and MMS that were not deferred at the Area Identification stage on the basis of Call for Information and Nominations responses from affected States, other Federal agencies, environmental groups, and the general public, as well as other considerations. Biological, archaeological, and military areas stipulations are being considered for adoption as mitigating measures.

Central Gulf Sale 110 is scheduled for April 1987 in the Final 5-Year OCS Oil and Gas Leasing Schedule (July 1982). There were 5,821 unleased blocks containing approximately 31.4 million acres were present in the CPA as of October 1985. The actual number of blocks offered for lease will differ from the October 1985 figure by an amount equal to the number of blocks relinquished, cancelled, and terminated less the number of blocks leased (proposed Central Gulf Sale 104) during the intervening period. Unleased blocks are located from approximately 3-220 miles offshore in water depths ranging from approximately 4 m to over 3,200 m.

The analysis of impacts summarized below and described in detail in Section IV.D.1.a. is based on a development scenario (Most Likely Find or M Scenario) formulated to provide a set of assumptions and estimates on the amounts, locations, and timing for OCS exploration, development, and production operations and facilities, both offshore and onshore. A detailed discussion of the development scenario and major related impact producing factors is included in Section IV.A. Table II-1 summarizes major elements of the development scenario and related impact producing factor's for the proposed action. The following major assumptions and estimates are included in the development scenario and considered in the impact assessment.

- The discovery and production of 0.260 billion bbls of oil and 2.150 trillion cubic feet (tcf) of gas during the period 1988-2010.

- The drilling of 320 exploration and delineation wells during the period 1988-1998.

- The installation of 34 production platforms and the drilling of 408 development wells during the period 1989-2000.

- Oil and gas production beginning in 1989 and reaching peak annual production during the period 1995-1997 for oil (23.4 million bbls) and during the period 1998-2000 for gas (193.5 billion cubic feet).

- Estimated drilling mud solid discharges of 3.30 million bbls and estimated drill cutting discharges of 0.37 million cubic yards.

- All gas production and most oil production (at least 80%) transported by pipeline to onshore processing facilities in the central coastal area. Some oil production (up to 20%) transported by shuttle tanker to existing port/terminal facilities and then moved by pipeline (existing network) to processing facilities in the central coastal area.

- The construction of 200 miles of offshore pipeline and up to three new pipeline landfalls with up to 60 miles of onshore routing.

Table II-1

Proposed Action - Central Gulf Sale 110
Summary: Major Elements of the M Scenario and Related Impact Producing Factors

Resources Expected to be Developed[1]	
Oil (billion bbls)	0.260
Gas (tcf)	2.150
Peak Annual Production[2]	
Oil	0.023
Gas	0.194
Offshore Infrastructure	
Exploration and Delineation Wells Drilled	320
Production Platforms Installed	34
Development Wells Drilled	408
Pipeline (miles constructed)[3]	200
Transportation Assumptions	
Oil - Pipelined (billion bbls/%)	0.208/80
Oil - Shuttle Tankered (billion bbls/%)	0.052/20
Gas - Pipelined (tcf/%)	2.150/100
Offshore Discharges[4]	
Drilling Mud Material (million bbls)	3.30
Drill Cuttings (million cubic yards)	0.37
Formation Waters (billion bbls)	0.003-0.23
Offshore Air Emissions (peak year - 1,000 tons)	
NO_x	1.93
CO	0.33
SO_x	0.22
VOC	0.06
TSP	0.01
New Onshore Facilities[5]	
Service Bases (number/acres)	1/25
Pipeline Landfalls (number)	3
Pipeline (miles constructed/acres)	60/720
Shuttle Tanker Traffic (20,000 dwt/50,000 dwt)[6]	46/18
Service Vessel Traffic[6]	8,900
Helicopter Traffic[6]	21,000
Oil Spills: Occurrences/Probability of Occurrence/ Probability of Contact[7]	
Large Spills (≥1,000 bbls)	1/47/27
Medium Spills (50-999 bbls)	4/97/80
Small Spills (1-49 bbls)	99/99+/99+

[1] Estimates of oil and gas expected to be discovered and produced as a result of the proposed actions.

[2] Both oil and gas production are expected to occur over the 22-year period, 1989-2010. Peak oil production would occur from 1995 through 1997, and peak gas production would occur from 1998 through 2000.

[3] Gathering and main pipelines.

[4] Total amount.

[5] Maximum number in expected range. See Table IV-4 for location by coastal subareas.

[6] Number of trips (outbound plus inbound) for peak year activity. For shuttle tanker traffic, the number of trips using 20,000 dwt and 50,000 dwt tankers is shown.

[7] The assumed number of spill occurrences, the probability (expressed as percent chance) of one or more spills occurring, and the probability (expressed as percent chance) of one or more spills occurring and contacting land within 10 days. Spills are assumed to occur during the 22-year production period (1989-2010). The average size of a large spill is estimated at about 17 thousand bbls; the average medium spill is estimated at 154 bbls; and the average small spill is estimated at 4.2 bbls based on historic statistics.

Source: USDI Minerals Management Service, Gulf of Mexico OCS Region.

- Onshore support activities being provided from existing facilities in Louisiana, Mississippi, Alabama, and Texas, with possibly one new service base established to support offshore drilling and production operations. Likely potential locations for a new service base (using up to 25 acres) include Harrison and Jackson Counties in Mississippi and Mobile County in Alabama.

- The occurrence of one large oil spill ($\geq$ 1,000 bbls) as a result of the proposed action is assumed for analysis. This is considered a reasonable assumption on the basis of the historic spill rates used in the Oil Spill Risk Analysis (OSRA) which estimated that there would be a 47% chance of one or more such spills. The sale specific analyses of the expected effects of spills focus on the resources which are sensitive to oil and on the specific geographic locations where a potential impact causing event (a contact or interaction with the spill) could occur. The OSRA estimated probabilities of one or more large spills occurring and contacting land, land segments, and selected environmental targets within 10 days are listed in Table IV-19. These OSRA estimates indicate there is a 27% chance of such a contact with land and that the following eight land segments (all in Louisiana) have a 1% or greater chance of being contacted by such a spill: 12 (Cameron Parish - 2%; 13 (Vermilion Parish) - 4%; 14 (Iberia Parish) - 3%; 16 (Terrebone Parish) - 9%; 17 (Lafourche Parish) - 2%; 18 (Jefferson Parish) - 1%; 19 (Plaquemines Parish) - 5%; 20 (St. Bernard/Orleans/St. Tammany Parishes) - 5%.

b. Summary of Impacts

The following are summaries of the detailed impact analyses which are included in Section IV.D.1.a. It is noted that these summaries are limited to the impact of the proposed action alone (under the M Scenario); the cumulative impacts which are discussed in Section IV.D.1.a. are not summarized here. Table S-3 indicates the level of impact on each resource category estimated as a result of the cumulative factors.

Five levels of impact are defined for each impact topic and used in the conclusion to indicate the degree of intensity or severity of the impact judged from the analysis. The five levels are designated by the following qualitative terms indicating the degree of impact: very high; high; moderate; low; and very low. Definitions of these impact levels for each resource category are provided in Table S-4.

To facilitate the analysis, the Federal offshore area is divided into subplanning areas (the CPA is comprised of four subplanning areas: C-1, C-2, C-3, and C-4). In addition, the coastal region is divided into coastal subareas (the Central Coastal Area is comprised of four coastal subareas: C-1, C-2, C-3, and C-4). These subareas are delineated on Figure IV-1.

(1) Impacts on Sensitive Coastal Habitats

(a) Barrier Beaches/Islands

As a result of the anticipated leasing activities associated with proposed lease Sale 110, it is estimated that the greatest potential for impact to barrier beaches/islands would result from pipeline emplacement in coastal subarea C-2. In coastal subarea C-2 (St. Mary, Terrebonne, Lafourche, and Jefferson Parishes, Louisiana) up to one oil/gas transmission pipeline is estimated. Based on two possible routing scenarios for C-2, a maximum of 13.8 acres of habitats could be altered, representing an alteration of 0.09% of these habitat types within coastal subarea C-2. The construction trench through the beach would result in short-term, localized changes; however, that portion of the trench that is cut through the dune ridge could create a major zone of environmental disturbance. This area is a zone of potential instability and is often difficult to restore. It is not certain that adverse impacts to this area would be ameliorated through the implementation of rigid construction practices and proper scheduling, the employment of mitigating measures, and the restoration of the dune system. Should they occur, these controls would be state administered.

One large spill (1,000 bbls or greater) is assumed for analysis purposes, and although the probability for a contact is less than 10%, in the event a spill were to contact the severely eroding barrier beach network in south Louisiana, high to very high impacts could result.

Terrebonne, Lafourche, Jefferson, and Plaquemines Parishes contain barrier beach systems which are exposed and highly vulnerable to contact from potential oil spills resulting from the proposed action. Clean-up activities could result in the removal of large volumes of beach sands from the beach front and dune areas, resulting in a loss of greater than 2% of the existing barrier habitats within this region. Due to the dwindling sand supplies in the Louisiana coastal region, removal of contaminated sand material during spill clean-up operations could result in accelerating the current rates of erosion within these areas, if not replaced by a clean sand source soon after the contaminated material is removed from the site. It is unlikely that such a technique would be utilized due to the remoteness of many of these areas with the exception being Grand Isle, Louisiana. In most instances, the majority of the surface oil would be soaked up using absorbent pads and leaving the remainder of the oil to weather on the beach. Clean-up activities would be coordinated with State officials as to the method of clean-up to be utilized.

No new ancillary facility construction (pipeline support) or new navigation canals are expected to result from the proposed action. However, maintenance dredging of existing navigation canals occurs periodically and this in itself interferes with dynamics (littoral system) of such a complex system, endangering the natural deposition of sand/sediment and the self maintenance of its features.

The level of expected impact on barrier beaches/islands is estimated to be low in coastal subarea C-2 and very low in the rest of the CCA; however, the overall level of impacts to the CCA will be low.

(b) Wetlands

The potential construction of possibly 3 pipelines, about 60 miles of onshore pipeline, and 1 service base as a result of the proposed action could cause interference, alteration, or destruction to coastal wetlands in the following amounts: up to 72 acres in coastal subarea C-1; up to 168 acres in subarea C-2; up to 180 acres in subarea C-3; and up to 25 acres in subarea C-4. The probability of one or more oil spills occurring and contacting wetlands in the CPA range from a high of 9% in Terrebonne Parish to less than 0.5% in St. Mary Parish. Such contacts are expected to cause low to moderate impacts depending on the specific habitats contacted. The expected levels of impact on coastal wetlands as a result of the proposed action are estimated to be low in coastal subareas C-1, C-3, and C-4 and moderate in subarea C-2. Overall, the level of impact on coastal wetlands in the CCA resulting from the proposed action is estimated to be low.

(2) Impacts on Sensitive Offshore Habitats

As described in Section IV.D.1.a.(3), the major potential impact producing factors that could affect the biota of the topographic features and the live bottom areas in the Central Gulf are oil spills; blowouts; anchor, rig, platform, and pipeline emplacements; and discharge of drilling fluid. Oil and gas operations resulting from this proposal could cause very high and potentially long-lasting damage due to the relatively small coral and coral community areas of the Gulf if unrestricted operations take place on or near these important sensitive habitats. High deleterious impacts to fish habitats of the topographic features and live bottoms (pinnacle trend) may also affect the recreational and commercial fisheries of the area, and the intrinsic biological, ecological, and aesthetic values of these areas might be seriously diminished.

The proposed stipulation described in this section would preclude nearly all of the adverse impacts from the routine oil and gas lease operations. The topographic features stipulation would mitigate impacts to the biota resulting in a very low expected level of impact. The live bottom stipulation is expected to result in a very low level of impact to live bottoms.

(3) Impacts on Water Quality

(a) Offshore

As a result of Sale 110, localized offshore water quality degradation will occur in the CPA. Immediate impacts would be brought on by increased drilling of up to 320 exploration and delineation wells, 408 development wells, construction, and pipelaying activities resulting in laying up to 200 miles of pipeline. Other impacts would stem from additional dredging activities, and discharges of drilling muds, fluids, cuttings, sanitary and domestic wastes, and formation waters from the 34 platforms projected for this area. The expected impacts are estimated to be high around platforms and construction sites depending on existing local water conditions, with the extent of such impacts extending from only a few meters to tens of meters from these sites. These impacts will decrease to very low with distance (500-1,000 m) from the source. The overall impact to offshore water quality is estimated to be low.

(b) Onshore

Onshore water quality degradation will occur as a result of increased nonpoint and point sources of pollution, especially in those areas of Louisiana (Calcasieu Basin, Mississippi Delta), Mississippi (Pascagoula area), and Alabama (Mobile Bay) where water quality problems already exist. Any increased point source impacts from a new service base in coastal subarea C-4 can be mitigated by Federal and State regulations and guidelines. Nonpoint source impacts may be minimized by controlling erosional effects generated within all construction site boundaries, especially with regards to the up to 60 miles of onshore pipeline projected for coastal subareas C-1 (20), C-2 (20), and C-3 (20); therefore, expected impacts to onshore water quality would be low.

(4) Impacts on Air Quality

Air quality degradation may occur from catastrophic events (blowouts and oil spills) and offshore operational emissions as a result of drilling, platform installation, and production. Additional gas processing or refining capability is not expected to be needed as a result of this lease sale. Impacts resulting in slight increases of some criteria pollutants are assumed to be felt in areas classified as nonattainment or Prevention of Significant Deterioration (PSD) Class I areas that may be adjacent to more dense OCS-related activities, i.e., Mobile County in Alabama, and St. Bernard, Plaquemines, St. Mary, Lafourche, St. Charles, Jefferson, Orleans, and St. John the Baptist Parishes in Louisiana. Coastal air quality could deteriorate if an unflared blowout causes the uncontrolled release of sour gas into the atmosphere within 3-5 miles of shore. The expected levels of OCS-related activities (34 platforms and no new gas processing or refining facilities) should cause little long-term degradation of ambient air quality with no significant effects on nonattainment or PSD areas. (For a detailed analysis, see Section IV.D.1.a.(4).) Short-term degradation of air quality could occur as a result of uncontrolled release of sour gas from a blowout. Moderate impacts would be expected in St. Bernard, Plaquemines, St. Mary, Lafourche, St. Charles, Jefferson, Orleans, and St. John the Baptist Parishes in Louisiana and in Mobile County in Alabama. Very low impacts are expected throughout the remainder of the coastal area of the Central Gulf.

(5) Impacts on Endangered and Threatened Species

The impact producing factors which could affect endangered and threatened species as a result of the proposed action include oil spills, collision with offshore-related support vessels, and disturbance from offshore and onshore activities.

(a) Brown Pelicans

There is a 9% probability of one or more oil spills occurring and contacting pelican habitat in Terrebonne Parish. One potential onshore service base in Jackson County, Mississippi; or Mobile County, Alabama, and three potential pipeline landfalls with up to 60 miles of onshore pipeline in Louisiana are unlikely to affect brown pelicans or their habitats in these areas. The expected level of impact on brown pelicans is estimated to be very low.

(b) Marine Mammals (Whales)

There is a low probability of one or more spills occurring and contacting deepwater areas of the continental shelf where whales occur. Offshore support vessel traffic is estimated at about 3% of overall annual vessel traffic in this coastal area and is not likely to impact whales. The disturbance and noise associated with seismic exploration and drilling about 320 wells will be short-term and localized near drilling sites. The expected level of impact on whales is estimated to be very low.

(c) Sea Turtles

There is a 2% probability of one or more oil spills occurring and contacting sea turtle nesting habitat and less than a 10% probability of one or more oil spills occurring and contacting sea turtle foraging areas off the central Louisiana coast. Offshore support vessel traffic into Louisiana ports is estimated at about 3% of the overall annual vessel traffic and is not likely to impact sea turtles. One potential onshore service base in Jackson County, Mississippi, or Mobile County, Alabama, and three potential pipeline sites in Louisiana are unlikely to affect sea turtles or their habitats in these areas. The expected level of impact on sea turtles is estimated to be low.

(6) Impacts on Coastal and Marine Birds

The impact producing factors which could affect coastal and marine birds as a result of the proposed action include oil spills and disturbance from onshore construction. The highest probability of one or more oil spills occurring and contacting coastal and marine bird habitat is 9% in Terrebonne Parish. This moderate probability of oil spill contact indicates a potential for oil contamination of bird species which feed in inshore waters of the Central Gulf area. One potential service base requiring a total of 25 acres in Jackson County, Mississippi, and/or Mobile County, Alabama, and three potential pipeline sites requiring about 840 acres in Louisiana are unlikely to affect coastal and marine birds and their habitats in these areas. The expected level of impact on coastal and marine birds is estimated to be low.

(7) Impacts on the Commercial Fishing Industry

Several impact producing factors from this alternative could affect the commercial fishing industry, including loss of fishing area through construction of platforms/structures, gear conflicts, and oil spills. As a result of these impact producing factors, a moderate impact (a 1% or less economic loss to the commercial fishing industry, some financial loss and inconvenience to the fishermen, and secondary employment affected) could occur to the commercial fishing industry.

(8) Impacts on Major Shorefront Recreational Beaches

There is a 3% probability that one large 10 day old spill (1,000 bbls or greater) as well as several smaller spills would occur and contact major shorefront recreational beaches in Louisiana. Such spill contacts are expected to have a low level of impact. In addition, residuals such as tar balls and trash associated with offshore operations will intermittently wash ashore and add to the existing trash and debris problems associated with Gulf of Mexico beaches, causing localized, short-term inconveniences. The overall level of expected impact on major recreational beaches is estimated to be low.

(9) Impacts on Archaeological Resources

(a) Historic

The impact producing factors which would affect offshore and onshore historic sites include interactions with drilling rigs, platforms, pipelines, anchors, construction of onshore facilities, and contact by spilled oil. Should an interaction between one of these impact producing factors and an historic site occur, significant or unique historic information could be lost. Although the potential for such an interaction occurring is uncertain, if there is an interaction, there is potential for a high to very high impact.

The lease stipulation, if adopted, would reduce the potential for a very high impact to very low by allowing sites to be located prior to an interaction occurring, thereby making avoidance or mitigation of impacts possible. The exception to the lease stipulation's effectiveness is in subplanning areas C-2 and C-3 where the potential for a very high impact level would not be significantly reduced because of thick unconsolidated sediments which make the magnetometer the primary instrument for shipwreck detection. At 150 m linespacing the magnetometer provides only 25%-30% coverage of the survey area.

(b) Prehistoric

All of the impact producing factors which could affect offshore and onshore historic sites could affect prehistoric sites as well. Should an interaction between one of these impact producing factors and a prehistoric site occur, significant or unique archaeological information could be lost. Although the potential for such an interaction occurring is uncertain, if there is an interaction, there is potential for a high to very high impact.

The lease stipulation, if adopted, would reduce the potential for a very high impact to very low by allowing potential site areas to be located prior to an interaction occurring, thereby making avoidance or mitigation of impacts possible.

c. Proposed Mitigating Measures

(1) Topographic Features Stipulation

The topographic features of the Central Gulf provide habitat for coral and coral community organisms (Section III.B.2.). As discussed in Section IV.D.1.a.(3), these communities would be severely adversely impacted by unrestricted oil and gas activities resulting from the proposed action if such activities took place on or near these communities. DOI has recognized this problem for some years, and since 1974 stipulations have been made a part of leases on blocks on or near enough to these biotic communities for the nearby oil and gas activities to have an impact on these communities. This stipulation would not prevent the recovery of oil and gas resources, but it would serve to protect valuable and sensitive biological resources.

The topographic stipulation was developed by a DOI workshop of MMS and FWS biologists. Comments were solicited from Federal and State agencies, industry, academia, and interested environmental groups.

The stipulation wording is based on the scientific information collected over the past 12 years. This information includes various Bureau of Land Management/MMS-funded studies on the topographic highs in the Central Gulf, numerous stipulation-imposed, industry-funded monitoring reports, and the National Academy of Science (NAS) report entitled Drilling Discharges in the Marine Environment (1983). Based on this collection of information, biologists from the Department of the Interior (MMS and FWS) agreed that the proposed stipulation better reflects the current body of scientific knowledge. The stipulation was formulated based on consultation with various Federal agencies and comments solicited from State, industry, environmental organizations, and academic representatives.

The rationale for the requirements in the stipulation is based on the following facts:

(a) Shunting of the drilling effluent to the nepheloid layer contains the effluent to a level deeper than the level of the living reef of a high relief topographic feature. Shunting is therefore an effective measure for protecting the biota of high relief topographic features (Bright and Rezak, 1978; Rezak and Bright, 1981; NAS, 1983).

(b) Biological effect on the benthos from the deposition of unshunted discharge is mostly limited to within 1,000 m of the discharge (NAS, 1983).

(c) The biota of topographic features can be categorized into depth-related zones defined by degree of reef building activity (Rezak and Bright, 1981 and Rezak et al., 1983).

The stipulation would establish No Activity Zones at the topographic features. The zone is defined by the 85 m isobath because, generally, the biota shallower than 85 m are more typical of the Caribbean reef biota, while the biota deeper than 85 m are similar to soft bottom organisms found throughout the Gulf. Where a bank is in water depths less than 85 m, the deepest closing isobath defines the No Activity Zone for that bank. Within the No Activity Zone, no operations, anchoring, or structures would be allowed.

Outside the No Activity Zones, additional restrictive zones would be established within which oil and gas operations could occur but within which drilling discharges would be shunted.

The stipulation would require that all effluents within 1,000 m of the banks with the antipatharian-transitional zone be shunted to within 10 m of the seafloor. Banks containing the more sensitive and productive algal-sponge zone would require a shunt zone extending 1 nmi and an additional 3 nmi shunt zone for development. Because

Sweet Bank in the Central Gulf is small and surrounded by very deep water (the depth drops very quickly to greater than 200 m around the bank), it does not require the protection of the shunt zones; therefore, only a "No Activity Zone" would be established there.

The banks which would cause this stipulation to be applied to blocks of the Central Gulf are:

Bank Name	Isobath (meters)	Bank Name	Isobath (meters)
McGrail Bank	85	Parker Bank	85
Bouma Bank	85	Fishnet Bank[2]	76
Rezak Bank	85	Jakkula Bank	85
Sidner Bank	85	Sweet Bank[1]	85
Sonnier Bank	55	Rankin Bank	85
Sackett Bank	85	29 Fathom Bank	64
Ewing Bank	85	Bright Bank	85
Diaphus Bank[2]	85	Geyer Bank[3]	85
Alderdice Bank	80	MacNeil Bank[3]	82

[1] Only paragraph (a) of the stipulation applies.
[2] Only paragraphs (a) and (b) apply.
[3] Western Gulf of Mexico bank with a portion of its "3 Mile Zone" in Central Gulf of Mexico.

The stipulations read as follows:

Topographic Features Stipulation
(Central Planning Area)

(a) No structures, drilling rigs, pipelines, or anchoring will be allowed within the listed isobath ("No Activity Zone") of the banks as listed above.

(b) Operations within the area shown as "1,000 Meter Zone" shall be restricted by shunting all drill cuttings and drilling fluids to the bottom through a downpipe that terminates an appropriate distance, but no more than ten meters, from the bottom.

(c) Operations within the area shown as "1 Mile Zone" shall be restricted by shunting all drill cuttings and drilling fluids to the bottom through a downpipe that terminates an appropriate distance, but no more than ten meters, from the bottom. (Where there is a "1 Mile Zone" designated, the "1,000 Meter Zone" in paragraph (b) is not designated.)

(d) Operations within the area shown as "3 Mile Zone" shall be restricted by shunting all drill cuttings and drilling fluids from development operations to the bottom through a downpipe that terminates an appropriate distance, but no more than ten meters, from the bottom.

Effect of the Lease Stipulation

The purpose of the stipulation is to protect the biota of the topographic features from routine oil and gas activities, that is from physical damage from anchoring and rig emplacement and from muds and cuttings discharge. The topographic features stipulation has been used on leases for the past 12 years. Experience since 1974 shows conclusively that the stipulation works to prevent damage to the biota of these banks from routine oil and gas activities. Anchoring has been prevented from occurring on the sensitive portions of the features. Monitoring studies conducted as required by the stipulation have demonstrated that the shunting requirements are effective in preventing the muds and cuttings from impacting the biota of the banks. The proposed stipulation, if implemented, would continue to protect the biota of the banks specifically as discussed below.

Mechanical damage is probably the single most severe impact to benthic areas resulting from oil and gas operations. The "No Activity Zones" would completely eliminate this threat from leasing activities to the area within the zone. The sensitive biota would thus be protected.

The stipulation would require that all effluents within 1,000 m of Fishnet and Diaphus Banks (categorized by Rezak and Bright (1981) as a Category C banks) be shunted into the nepheloid layer. The biota of the antipatharian zone located at these banks would thus be protected from impact from drilling discharges within the 1,000 m zone because the potentially harmful materials (in drilling muds) would be trapped in the bottom boundary layer and would not get up on the bank where the biota of concern are located. Surface drilling discharge at distances greater than 1,000 m from the bank is not expected to impact the biota since effects from drilling discharge are mostly limited to 1,000 m.

The stipulation would protect the remaining Category A and B banks with greater restrictions. (Sackett Bank is categorized as a Category C bank; however, it contains the algal-sponge community which is indicative of Category A banks and is, therefore, stipulated as a Category A bank.) Surface discharge would not be allowed within 1 nmi of these more sensitive banks. Thus, the stipulation would prevent impacts to the biota of these sensitive banks from drilling discharges within 1 nmi. Surface discharges outside of 1 nmi are not expected to impact the biota of the banks as effects from surface discharge are mostly limited to 1,000 m. However, it is possible that extremely small amounts of muds discharged more than 1 nmi from the bank may reach the bank. In order to eliminate the possible cumulative effect of muds discharged from numerous wells outside of 1 nmi, the stipulation would impose a "3 Mile Zone" in which shunting of development effluent would be required.

The stipulation would prevent damage to the biota of the banks from routine oil and gas activities resulting from the proposed action. Furthermore, oil and gas resources present near such areas could be recovered. However, the stipulation would not protect the banks from the adverse effects of an accident such as a large blowout on a nearby oil or gas operation. Fortunately, blowouts are rare in the Gulf.

(2) Live Bottom Stipulation

A small portion of the northeastern CPA is characterized by a pinnacle trend which is classified as a live bottom under the definition:

> Live bottom areas are defined as seagrass communities; or those areas which contain biological assemblages consisting of such sessile invertebrates as sea fans, sea whips, hydroids, anemones, ascidians, sponges, bryozoans, or corals living upon and attached to naturally occurring hard or rocky formations with rough, broken, or smooth topography; or areas whose lithotype favors the accumulation of turtles, fishes, or other fauna.

The pinnacles in the trend could be impacted from physical damage of unrestricted oil and gas activities. The live bottom stipulation is intended to protect the pinnacle trend from damage and, at the same time, provide for recovery of oil and gas resources.

Numerous live bottom surveys have been conducted in the area based on the application of this stipulation on previously leased blocks. These surveys, along with the recently finalized Tuscaloosa Trend Study (Vittor and Associates, 1985), indicate that numerous, hard bottom associated live bottoms (common in the EPA) are not expected in the CPA, as once thought. The stipulation was developed by a DOI workshop of MMS and FWS biologists. Comments were solicited from Federal and State agencies, industry, academia, and interested environmental groups.

The stipulation reads as follows:

Live Bottom Stipulation
(Central Planning Area)

> (To be included only on leases in the following blocks: Main Pass Area, South and East Addition Blocks 219-226, 244-266, 276-288; Viosca Knoll Blocks 521, 522, 564, 565, 566, 609, 610, 654, 692-698.)

For the purpose of this stipulation, "live bottom areas" are defined as seagrass communities; or those areas which contain biological assemblages consisting of such sessile invertebrates as sea fans, sea whips, hydroids, anemones, ascidians, sponges, bryozoans, or corals living upon and attached to naturally occurring hard or rocky formations with rough, broken, or smooth topography; or areas whose lithotope favors the accumulation of turtles, fishes, and other fauna.

Prior to any drilling activities or the construction or placement of any structure for exploration or development on this lease, including, but not limited to, well drilling and pipeline and platform placement, the lessee will submit to the Regional Director (RD) a live bottom survey report containing a bathymetry map prepared utilizing remote sensing techniques. The bathymetry map shall be prepared for the purpose of determining the presence or absence of live bottoms which could be impacted by the proposed activity. This map shall encompass such an area of the seafloor where surface disturbing activities, including anchoring, may occur.

If it is determined that the live bottoms might be adversely impacted by the proposed activity, the RD will require the lessee to undertake any measure deemed economically, environmentally, and technically feasible to protect the pinnacle area. These measures may include, but are not limited to, the following:

(a) the relocation of operations; and

(b) the monitoring to assess the impact of the activity on the live bottoms.

Effect of the Lease Stipulation

The pinnacle trend is known to exist in a general area in the CPA; however, the trend is patchy. The stipulation would operate to identify the individual pinnacles which may be present in the block. The stipulation would require that a survey be done to encompass the potential area of proposed surface disturbance and that a bathymetry map be made from this survey. The bathymetry map would depict any pinnacles in the vicinity of the proposed activity. (Since it is the pinnacles themselves and the habitat they provide for various mobile species, rather than the attached biota thereon, which are sensitive to impacts from oil and gas activities, photodocumentation of the identified pinnacles is not warranted.) The RD, through consultation with the FWS, could then decide if pinnacles in the trend would be potentially impacted and, if so, any appropriate mitigative measures.

By identifying the individual pinnacles present at the activity site, the lessee could be directed to avoid placement of the drilling rig and anchors on the sensitive areas. Thus, mechanical damage to the pinnacles would be eliminated by the imposition of the stipulation. The stipulation does not address the discharge of effluents near the pinnacles because the pinnacle trend is subjected to heavy natural sedimentation and, therefore, is unlikely to be affected by drilling discharge.

The live bottom stipulation has been used on leases over the past 11 years. Experience from the use of the live bottom stipulation in the Central and Eastern Gulf shows that the stipulation works to identify and protect the live bottom biota.

(3) Archaeological Resource Stipulation

(a) "Archaeological resource" means any prehistoric or historic district, site, building, structure, or object (including shipwrecks); such term includes artifacts, records, and remains which are related to such a district, site, building, structure, or object. (Section 301(5), National Historic Preservation Act, as amended, 16 U.S.C. 470w(5). "Operations" means any drilling, mining, or construction or placement of any structure for exploration, development, or production of the lease.

(b) If the Regional Director (RD) believes an archaeological resource may exist in the lease area, the RD will notify the lessee in writing. The lessee shall then comply with subparagraphs (1) through (3).

(1) Prior to commencing any operations, the lessee shall prepare a report, as specified by the RD, to determine the potential existence of any archaeological resource that may be affected by operations. The report, prepared by an archaeologist and geophysicist, shall be based on an assessment of data from remote-sensing surveys and of other pertinent archaeological and environmental information. The lessee shall submit this report to the RD for review.

(2) If the evidence suggests that an archaeological resource may be present, the lessee shall either:

(i) Locate the site of any operation so as not to adversely affect the area where the archaeological resource may be; or

(ii) Establish to the satisfaction of the RD that an archaeological resource does not exist or will not be adversely affected by operations. This shall be done by further archaeological investigation, conducted by an archaeologist and a geophysicist, using survey equipment and techniques deemed necessary by the RD. A report on the investigation shall be submitted to the RD for review.

(3) If the RD determines that an archaeological resource is likely to be present in the lease area and may be adversely affected by operations, he will notify the lessee immediately. The lessee shall take no action that may adversely affect the archaeological resource until the RD has told the lessee how to protect it.

(c) If the lessee discovers any archaeological resource while conducting operations on the lease area, the lessee shall report the discovery immediately to the RD. The lessee shall make every reasonable effort to preserve the archaeological resource until the RD has told the lessee how to protect it.

There are two archaeological management zones in the Gulf of Mexico (Figure II-1). Zone 1 has a high potential both for the occurrence of historic shipwrecks and for prehistoric sites. Zone 2 has a high potential only for prehistoric sites. All blocks leased in Sales 110 and 112, which fall within Archaeological Zones 1 or 2, will require a remote sensing survey as specified in NTL 75-3 (Revision No. 1). Additionally, all blocks containing known shipwrecks (Tables III-18 and III-19) which fall outside Zones 1 and 2 would require surveys at 150 m linespacing, if leased.

The lease stipulation reduces the potential for an interaction between an impact producing factor and an archaeological site by allowing sites to be located prior to lease development, thereby making avoidance or mitigation of impacts possible.

Effect of the Lease Stipulation

Historic

The two principle instruments for shipwreck detection are the magnetometer and the side scan sonar. For locating small historic shipwrecks (e.g., of wooden construction), 150 m linespacing provides only about a 25%-30% sample of the seafloor with the magnetometer (Clausen and Arnold, 1975). However, at this linespacing, side scan sonar can provide well over 100% coverage of the seafloor with good resolution.

In areas with a relatively hard bottom or in areas with only a thin veneer of unconsolidated sediments, it is probable that there would be some evidence on the side scan sonar records of any shipwreck within the survey area. Within these areas, the stipulation is estimated to be very effective in ensuring detection of historic shipwrecks. However, across some portions of the Gulf of Mexico, the thickness of unconsolidated sediments is sufficient to completely conceal debris from most pre-20th century wrecks of wooden or composite construction (Clausen and Arnold, 1975). The primary instrument for shipwreck detection in this case would be the magnetometer. According

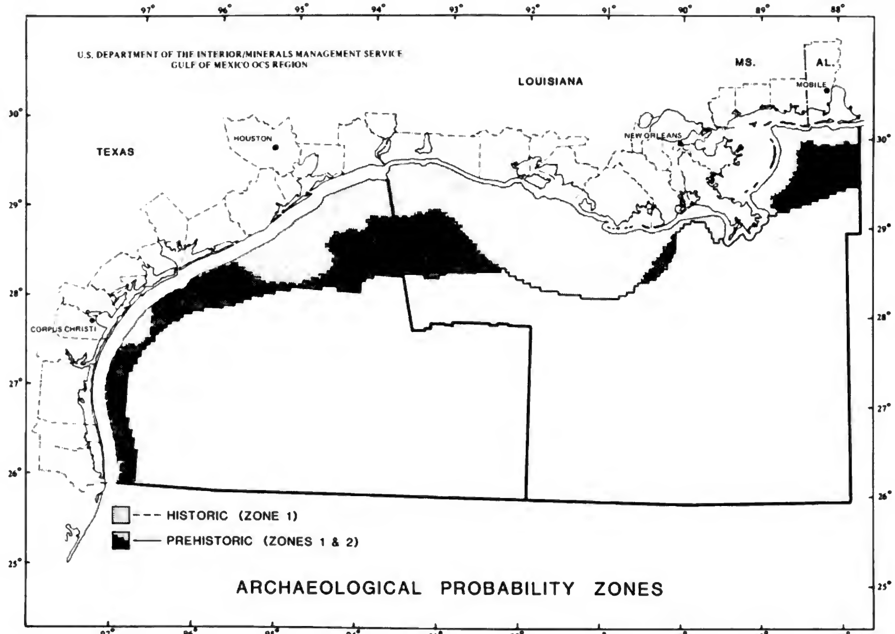

U.S. DEPARTMENT OF THE INTERIOR/MINERALS MANAGEMENT SERVICE
GULF OF MEXICO OCS REGION
TEXAS
LOUISIANA
MS.
AL.
HOUSTON
CORPUS CHRISTI
NEW ORLEANS
MOBILE
97°
96°
95°
94°
93°
92°
91°
90°
89°
88°
30°
29°
28°
27°
26°
25°
HISTORIC (ZONE 1)
PREHISTORIC (ZONES 1 & 2)
ARCHAEOLOGICAL PROBABILITY ZONES

Figure II-1

to the results of studies conducted by various marine archaeologists in their work with shipwrecks (Clausen and Arnold, 1975; Watts, 1980, Personal communication; and Saltus, 1982) at 150 m linespacing, it is possible to pass by an historically significant shipwreck with no indication on the magnetometer record. Within these areas, the stipulation is estimated to be much less effective in detecting historic shipwrecks. The only way to increase the effectiveness of the stipulation within these areas would be to reduce the survey linespacing to provide more intensive magnetometer coverage or to require industry to restrict all development actions to coincide with a survey line.

Prehistoric

The subbottom profiler is the primary instrument utilized in evaluating the prehistoric site potential of a lease area. In order to construct plan-view maps of the near-surface stratigraphy and geomorphology within a survey area, it is necessary to interpolate between survey lines, regardless of the survey linespacing.

General information on the near surface geology within a lease area, such as the type of geomorphic features present, their probable environment of and period of formation, general state of preservation, and depth of burial, could be determined equally well with data at either 150 or 300 m linespacing. This information is what helps in determining the potential for the occurrence, preservation, and recovery of prehistoric sites.

The accuracy in mapping the relict geomorphology in plan-view from data collected at 300 m linespacing could be diminished by as much as 50% when compared to the accuracy obtainable at 150 m linespacing. This could subsequently diminish the accuracy in delineation of specific zones within a lease area which have a high probability for the occurrence of prehistoric sites. However, since geologic features are not entirely unpredictable in their general orientation and trend, this loss in mapping accuracy would probably not be significant in most cases.

For a summary of the estimated effectiveness of the survey methods discussed above in ensuring the location or identification of relict shelf geomorphic features having a high probability for associated prehistoric sites, see Volume 1, Section II.A.1.c.(2), Table II-2 of the Final Regional EIS.

(4) Military Areas Stipulation

This stipulation has been applied to blocks in military warning areas in past lease sales in the Central Gulf. The warning areas are shown on Figure I-4. When exploratory drilling and related service vessel traffic and helicopter flights have occurred in a warning area, the military has been informed of all drilling activity, vessel trips, and air flights. The military has had no problems to date with joint usage and has always recommended utilizing the stipulation on all leasing operations within their warning areas.

The stipulation reads as follows:

Military Areas Stipulation

Hold Harmless

> Whether compensation for such damage or injury might be due under a theory of strict or absolute liability or otherwise, the lessee assumes all risks of damage or injury to persons or property, which occur in, on, or above the outer continental shelf, to any persons or to any property of any person or persons who are agents, employees, or invitees of the lessee, its agents, independent contractors, or subcontractors doing business with the lessee in connection with any activities being performed by the lessee in, on, or above the outer continental shelf, if such injury or damage to such person or property occurs by reason of the activities of any agency of the United States government, its contractors or subcontractors, or any of their officers, agents or employees, being conducted as a part of, or in connection with the programs and activities of the command headquarters listed in Table II-2.
>
> Notwithstanding any limitation of the lessee's liability in Section 14 of the lease, the lessee assumes this risk whether such injury or damage is caused in whole or in part by any act or omission, regardless of negligence or fault, of the United States, its contractors or subcontractors, or any of its officers, agents, or employees. The lessee further agrees to indemnify and save harmless the United States against all claims for loss, damage, or injury sustained by the lessee, or

to indemnify and save harmless the United States against all claims for loss, damage, or injury sustained by the agents, employees, or invitees of the lessee, its agents, or any independent contractors or subcontractors doing business with the lessee in connection with the programs and activities of the aforementioned military installation, whether the same be caused in whole or in part by the negligence or fault of the United States, its contractors, or subcontractors, or any of its officers, agents, or employees and whether such claims might be sustained under a theory of strict or absolute liability or otherwise.

Electromagnetic Emissions

The lessee agrees to control his own electromagnetic emissions and those of his agents, employees, invitees, independent contractors or subcontractors emanating from individual designated defense warning areas in accordance with requirements specified by the commander of the command headquarters listed in Table II-2 to the degree necessary to prevent damage to, or unacceptable interference with, DOD flight, testing or operational activities, conducted within individual designated warning areas. Necessary monitoring control, and coordination with the lessee, his agents, employees, invitees, independent contractors or subcontractors, will be affected by the commander of the appropriate onshore military installation conducting operations in the particular warning area; provided, however, that control of such electromagnetic emissions shall in no instance prohibit all manner of electromagnetic communication during any period of time between a lessee, its agents, employees, invitees, independent contractors or subcontractors and onshore facilities.

Operational

The lessee, when operating or causing to be operated on its behalf, boat or aircraft traffic into the individual designated warning areas shall enter into an agreement with the commander of the individual command headquarters listed in Table II-2, utilizing an individual designated warning area prior to commencing such traffic. Such an agreement will provide for positive control of boats and aircraft operating into the warning areas at all times.

Table II-2

Warning Areas' Command Headquarters

Central Planning Area

Warning Areas	Command Headquarters
W-155	Naval Air Training Command Training Wing Six Naval Air Station Pensacola, Florida
W-453	Air National Guard Training Site Gulfport, Mississippi
W-92	Naval Air Station New Orleans, Louisiana
Eglin Water Test Areas 1 and 3	Commander Armament Division Eglin AFB, Florida

Western Planning Area

Warning Areas	Command Headquarters
W-228	Naval Air Training Command Naval Air Station Corpus Christi, Texas
W-602	Director of Training Deputy Chief of Staff, Operations Headquarters Strategic Air Command Offutt AFB, Nebraska

Effect of the Lease Stipulation

The hold harmless section of the military stipulation serves to protect the United States Government from liability in the event of an accident involving the lessee and military activities. The actual operations of the military and the lessee and his agents will not be affected.

The electromagnetic emissions section of the stipulation requires the lessee and his agents to reduce and curtail within some areas the use of radio, CB, or other equipment emitting electromagnetic energy. This serves to reduce the impact of oil and gas activity on the communications of military missions and reduces the possible effects of electromagnetic energy transmissions on missile testing, tracking, and detonation.

The operational section requires notification to the military of oil and gas activity to take place within a military use area. This allows the base commander to plan military missions and maneuvers to avoid the areas where oil and gas activities are taking place, or to schedule around the activities. Prior notification helps to reduce the potential impacts associated with vessels and helicopters traveling unannounced through areas where military activities are underway.

The military stipulation reduces potential impacts, particularly in regards to safety, but does not reduce or eliminate the actual physical presence of oil and gas operations in areas where military operations are conducted. The best indicator of the overall effectiveness of the stipulation may be that there has never been an accident involving a conflict between military operations and oil and gas activities.

d. Notice to Lessees and Operators (NTL) 83-3 Concerning Shallow Hazards for the Gulf of Mexico OCS Region

NTL 83-3 specifies the requirements to ensure that all exploratory, development, and production operations are conducted with a minimum risk to human life and the environment. The NTL in its entirety comprises Appendix B. NTL 83-3 applies to all existing and future leases and pipeline rights-of-way in the Gulf of Mexico. Prior to any seafloor disturbing activities at proposed drilling sites, platform sites or pipeline routes, a lessee or operator must assess any seafloor and subsurface geologic or man-made features and conditions which may have an adverse effect on the proposed operations. Seafloor geologic hazards include fault scarps, gas vents, unstable slopes, and reefs. Subsurface geologic hazards include faults, gas-charged sediments, abnormal pressure zones, and buried channels. Man-made hazards include pipelines, wellheads, shipwrecks, ordnances, communication cables, and debris from previous oil and gas activities.

NTL 83-3 consists of two basic parts: survey requirements and shallow hazards report.

Survey Requirements: The NTL requires geophysical instrumentation which is state-of-the-art in technological development, and all data recorders must be keyed to the navigation system to assure proper integration of information. Required geophysical instrumentation includes: (1) a total field intensity magnetometer to determine the presence of pipelines and other ferromagnetic objects; (2) a dual-channel side scan sonar to record continuous planimetric images of the seafloor; (3) a shallow, penetration subbottom profiler to determine the character of near-surface geological features; (4) a medium, penetration seismic profiler capable of penetrating at least 300 m (980 ft) to determine the character of deeper geological features; (5) a high-frequency, narrow-beam depth sounder to provide continuous water depth measurements; and (6) additional instrumentation such as underwater television, still or movie cameras, divers, coring, remote or manned submersibles, and additional geophysical survey lines that may be necessary under certain conditions. Survey parameters are also explicitly detailed.

Shallow Hazards Report: An evaluation of data gathered during the shallow hazards survey and a synthesis with other available geological and geophysical information is required. Reports must contain a description of the area (lease number, block number(s), OCS area(s), and water depth); a listing of individuals involved in the survey and report and a brief description of the duties of each; a discussion of the survey including navigation, instrumentation, and parameters (i.e., scale and sensitivity settings and tow depths); a description of the survey vessel and sensor configuration; sea and weather conditions; map(s) at a scale of 1:12,000 depicting navigation postplot, bathymetry, shallow geologic structures, deep geologic structures, and any anomalies detected by the instrumentation. The report also must include an assessment of the potential for shallow hazards within the survey area and a summary of conclusions and recommendations supported by the survey data and analyses. The report must be signed by a geologist or geophysicist specializing in high-resolution geophysical interpretation.

MMS reviews the shallow hazards survey and report, and if a potential hazard is identified within the area of proposed operations, the operator has three alternatives:

(1) relocate the proposed site of operations to avoid the potential shallow hazard;

(2) demonstrate to the Regional Supervisor, Offshore Rules and Production, that the use of special protective measures will minimize the risk to safe operations; or

(3) establish by further investigations deemed necessary by the Regional Supervisor that such operations will not be adversely affected by the shallow hazards.

2. Alternative B - No Action

a. Description of the Alternative

The alternative is equivalent to cancellation of a sale scheduled for a specific timeframe on the approved 5-year OCS Oil & Gas Leasing Schedule. Sales in the Central Gulf are scheduled on an annual basis. Therefore, the opportunity is postponed or foregone for development of the estimated 0.260 billion bbls of oil and 2.150 tcf of gas that could have resulted from this sale in the Central Gulf.

b. Summary of Impacts

All impacts, positive and negative, associated with the proposed action (as discussed in Section IV.D.1.a.) would be cancelled and the importation of foreign oil at present or increased levels would be continued. There would be an increased environmental risk of oil spills caused by tankering the oil. Adverse socioeconomic impacts could include loss of employment opportunities, payroll revenues, and tax revenues. The economic stability of the coastal region could be negatively affected. Also, see Section IV.D.1.d. for a discussion of the development of alternative energy supplies as replacement sources for lost domestic production. Table IV-32 presents replacement energy equivalents for the estimated resources for this sale.

3. Alternative C - Delete Biologically Sensitive Offshore Habitats

The deletion alternative is offered for the Secretary's consideration and would protect valuable offshore biological resources. It affects the biologically sensitive banks of the Central Gulf.

All of the blocks included in the deletion alternative are also the blocks which would be covered by the biological stipulations (discussed in Section II.A.1.c.(1)) which may be adopted by the Secretary to protect the biological habitats of these areas. Furthermore, the Secretary may choose to adopt only a part of the alternative, either alone or in conjunction with the proposed biological stipulation, in order to promote the environmental protection policies of the Department.

a. Description of the Alternative

This alternative would delete the 67 unleased blocks of the total 177 blocks which are on or near biologically sensitive areas of topographic features in the Central Gulf. This deletion alternative is presented as an environmental protection measure. The blocks that could be deleted under this alternative are the same as those referred to in Section II.A.1.c.(1) above and are listed in Appendix A.

b. Summary of Impacts

Selection of this alternative would serve to protect the sensitive high value coral communities of the Central Gulf from the potential harm resulting from oil and gas activities. All other impacts of this proposed action would be unchanged. (See Section IV.D.1.c. for a full discussion of the impacts of this alternative.) Furthermore, deletion of all these blocks would provide nearly full protection for the biota of these areas, while the biological stipulation of Section II.A.1.c.(1) would provide further control and reduce the potential impacts to very low but it would not remove all risk.

4. Comparison of Alternatives

Table S-3 provides a comparison and summary of the impact levels of the proposed action (Alternative A), no action (Alternative B), deletion of biologically sensitive offshore habitats (Alternative C), and the cumulative analyses for Sale 110. The definitions of the level of impact used are in Table S-4.

Alternative A, the proposed action, has the potential to result in very low, low, or moderate impacts to the resources with the exception of live bottom areas, topographic features, and archaeological resources. The biological, archaeological resources, and military areas stipulations are being considered for adoption as mitigating measures. These resources are expected to have high, very high, and very high levels of impact, respectively (without the proposed stipulations being in place). If the proposed stipulations are utilized, the levels of impact would be reduced to very low for these resources, except for historic shipwrecks in the eastern portion of the Central Gulf where the level of impact is still expected to be very high.

Alternative B, no action, would preclude any impacts to the resource categories listed in Table S-3 from the proposed action or other alternatives.

Alternative C, deletion of biologically sensitive offshore habitats, would preclude any impacts to topographic features and would have the same levels of impact as Alternative A for the remainder of the resource categories listed in Table S-3.

B. WESTERN GULF SALE 112

1. Alternative A - The Proposed Action

a. Description of the Proposed Action

The proposed action for Western Gulf Sale 112 (August 1987) is to offer for lease all unleased blocks in the Western Planning Area (WPA) of the Gulf of Mexico (Figure I-1), with the exception of two unique and highly sensitive blocks in the Flower Garden Banks (Blocks A-398 and A-375 in the High Island, East Addition, South Extension area) and 123 blocks adjacent to the provisional United States maritime boundary with the Republic of Mexico which have been deferred (these blocks have also been excluded from the last two Western Gulf sales, as well as proposed Sale 105 scheduled for August 1986). The proposed action is consistent with DOI's objective of offering for lease promising areas of hydrocarbon potential as identified by industry and MMS that were not deferred at the Area Identification stage on the basis of Call for Information and Nominations responses from affected States, other Federal agencies, environmental groups, the general public, and other considerations. Biological, archaeological, and military areas stipulations are being considered for adoption as mitigating measures.

Western Gulf Sale 112 is scheduled for July 1987 in the Proposed 5-Year OCS Oil and Gas Leasing Program (announced February 1986). There were 4,918 unleased blocks containing approximately 27.3 million acres present in the WPA as of December 1985. The actual number of blocks offered for lease will differ from the December 1985 figure by an amount equal to the number of blocks relinquished, cancelled, and terminated less the number of blocks leased (proposed Western Gulf Sale 105) during the intervening period. Unleased blocks are located from approximately 9-222 miles offshore in water depths ranging from approximately 8 m to over 3,000 m.

The analysis of impacts summarized below and described in detail in Section IV.D.2.a. is based on a development scenario (Most Likely Find or M Scenario) formulated to provide a set of assumptions and estimates on the amounts, locations, and timing for OCS exploration, development, and production operations and facilities, both offshore and onshore. A detailed discussion of the development scenario and major related impacat producing factors is included in Section IV.A. Table II-3 summarizes major elements of the development scenario and related impact producing factors for the proposed action. The following major assumptions and estimates are included in the development scenario for the proposed action.

- The discovery and production of 0.130 billion bbls of oil and 1.870 tcf of gas during the period 1988-2010.

- The drilling of 216 exploration and delineation wells during the period 1988-1998.

- The installation of 23 production platforms and the drilling of 276 development wells during the period 1989-2000.

- Oil and gas production beginning in 1989 and reaching peak annual production during the period 1995-1997 for oil (11.7 million bbls) and during the period 1998-2000 for gas (70.0 billion cubic feet).

- Estimated drilling mud solid discharges of 2.24 million bbls and estimated drill cutting discharges of 0.25 million cubic yards.

- All gas production and most oil production (at least 70%) transported by pipeline to onshore processing facilities in Texas and Louisiana. Some oil production (up to 30%) transported by shuttle tanker to existing port/terminal facilities in Texas and Louisiana, and then moved by pipeline (existing network) to processing facilities in the Texas and Louisiana coastal areas.

- The construction of up to 250 miles of offshore pipeline with up to two new pipeline landfalls (one each in coastal subareas W-1 and W-2), each with up to 20 miles of onshore routing.

- Onshore support activities being provided entirely from existing facilities in Texas and Louisiana, with up to two new service bases established to support offshore production operations. Likely potential locations for a new service base (using up to 25 acres) include Cameron, Willacy, Nueces, and San Patricio Counties in Texas.

- The occurrence of one large oil spill ($\geq$ 1,000 bbls) as a result of the proposed action is assumed for analysis. This is considered a reasonable assumption on the basis of the historic spill rates used in the Oil Spill Risk Analysis (OSRA) which estimated that there would be a 27% chance of one or more such spills. The sale specific analyses of the expected effects of oil spills focus on the resources which are sensitive to oil and on the specific geographic locations where a potential impact causing event (a contact or interaction with the spill) could occur. The OSRA estimates indicate there is a 14% chance for such a contact with land and that the following three land segments (all in Texas) have a 1% or greater chance of being contacted by such a spill: 8 (Matagorda County) - 1%; 9 (Brazoria County) - 3%; and 10 (Galveston/Chambers Counties) - 9%.

Table II-3

Proposed Action - Western Gulf Sale 112
Summary: Major Elements of the M Scenario and
Related Impact Producing Factors

Resources Expected to be Developed[1]	
Oil (billion bbls)	0.130
Gas (tcf)	1.870
Peak Annual Production[2]	
Oil	0.012
Gas	0.168
Offshore Infrastructure	
Exploration and Delineation Wells Drilled	216
Production Platforms Installed	23
Development Wells Drilled	276
Pipeline (miles constructed)[3]	250
Transportation Assumptions	
Oil - Pipelined (billion bbls/%)	0.091/70
Oil - Shuttle Tankered (billion bbls/%)	0.039/30
Gas - Pipelined (tcf/%)	1.870/100
Offshore Discharges[4]	
Drilling Mud Material (million bbls)	2.24
Drill Cuttings (million cubic yards)	0.25
Formation Waters (billion bbls)	0.001-0.12
Offshore Air Emissions (peak year - 1,000 tons)	
NO_x	1.44
CO	0.25
SO_x	0.16
VOC	0.05
TSP	0.01
New Onshore Facilities[5]	
Service Bases (number/acres)	2/50
Pipeline Landfalls (number)	2
Pipeline (miles constructed/acres)	40/480
Shuttle Tanker Traffic (20,000 dwt/50,000 dwt)[6]	35/14
Service Vessel Traffic[6]	2,900
Helicopter Traffic[6]	13,500
Oil Spills: Occurrences/Probability of Occurrence/ Probability of Contact[7]	
Large Spills (≥1,000 bbls)	1/27/14
Medium Spills (50-999 bbls)	21/82/59
Small Spills (1-49 bbls)	50/99+/99+

[1] Estimates of oil and gas expected to be discovered and produced as a result of the proposed actions.

[2] Both oil and gas production are expected to occur over the 22-year period, 1989-2010. Peak oil production would occur from 1995 through 1997, and peak gas production would occur from 1998 through 2000.

[3] Gathering and main pipelines.

[4] Total amount.

[5] Maximum number in expected range. See Table IV-5 for location by coastal subareas.

[6] Number of trips (outbound plus inbound) for peak year activity. For shuttle tanker traffic, the number of trips using 20,000 dwt and 50,000 dwt tankers is shown.

[7] The assumed number of spill occurrences, the probability (expressed as percent chance) of one or more spills occurring, and the probability (expressed as percent chance) of one or more spills occurring and contacting land within 10 days. Spills are assumed to occur during the 22-year production period (1989-2010). The average size of a large spill is estimated at about 17 thousand bbls; the average medium spill is estimated at 154 bbls; and the average small spill is estimated at 4.2 bbls based on historic statistics.

Source: USDI, Minerals Management Service, Gulf of Mexico OCS Region.

b. Summary of Impacts

The following are summaries of the detailed impact analyses which are included in Section IV.D.1.b. It is noted that these summaries are limited to the impact of the proposed action above (under the M Scenario); the cumulative impacts which are discussed in Section IV.D.2.a. are not summarized here. Table S-3 indicates the level of impact on each resource category estimated as a result of the cumulative factors.

Five levels of impact are defined for each impact topic and used in the conclusion to indicate the degree of intensity or diversity of the impact judged from the analysis. The five levels are designated by the following qualitative terms indicating the degree of impact: very high; high; moderate; low; and very low. Definitions of these impact levels for each research category are provided in Table S-4.

To facilitate the analysis the Federal offshore area is divided into subplanning areas (the WPA is comprised of three subplanning areas: W-1, W-2, and W-3). In addition, the coastal region is divided into coastal subareas (the Western Coastal Area is comprised of two coastal subareas: W-1 and W-2). These subareas are delineated on Figure IV-1.

(1) Impacts on Sensitive Coastal Habitats

(a) Barrier Beaches/Islands

As a result of the anticipated leasing activities associated with proposed lease Sale 112, it is estimated that the greatest potential for impact to barrier beaches/islands would result from pipeline emplacement in coastal subareas W-1 and W-2. In coastal subarea W-1 (San Patricio and Calhoun Counties) up to one oil/gas transmission pipeline is estimated, whereas, in coastal subarea W-2 (Jefferson and Matagorda Counties) 1-2 pipelines are estimated. Based on two possible routing scenarios for W-1, a maximum of 18.4 acres of barrier beach habitat could be altered as a result of construction activities. This represents an alteration of 0.01% of these habitat types within coastal subarea W-1. Based on the routing scenario for W-2, a maximum of 23 acres of barrier beach habitat could be altered, representing an alteration of 0.07% of these habitat types within coastal subarea W-2. The construction trench through the beach would result in short-term, localized changes; however, that portion of the trench that is cut through the dune ridge could create a major zone of environmental disturbance. This area is a zone of potential instability and is often difficult to restore. It is not certain that adverse impacts to this area would be ameliorated through the implementation of rigid construction practices and proper scheduling, the employment of mitigating measures, and the restoration of the dune system. Should they occur, these controls would be state administered.

Most of the counties along the Texas coastline contain barrier beach systems which are exposed and highly vulnerable to contact from potential oil spills resulting from the proposed action. One large spill (1,000 bbls or greater) is assumed for analysis purposes, and although the probability for a contact is less than 10%, in the event a spill were to contact the barrier beach network in Texas, high to very high impacts could result. Clean-up activities could result in the removal of large volumes of beach sands from the beach front and dune areas.

No new ancillary facility construction (pipeline support) or new navigation canals are expected to result from the proposed action. However, maintenance dredging of existing navigation canals occurs periodically and this in itself interferes with dynamics (littoral system) of such a complex, endangering the natural deposition of sand/sediment and the self maintenance of its features.

The level of expected impact on barrier beaches/islands is estimated to be very low in coastal subarea W-1 and low in coastal subarea W-2; however, the overall level of impacts to the WCA will be low.

(b) Wetlands

The construction of 2 service bases, 2 pipelines, and about 40 miles of onshore pipeline in coastal subareas W-1 and W-2 could result in the interference, alteration, or destruction of up to 37 acres of coastal wetlands in W-1 and 205 acres in W-2. The probability of one or more oil spills (1,000 bbls or greater) occurring and contacting wetlands in the WPA range from a high of 9% in Galveston County to a low of less than 0.5% in Cameron County, Texas. Such contacts are expected to cause very low to low impacts. The expected levels of impact on coastal wetlands as a result of the proposed action are estimated to be very low in coastal subarea W-1 and low in coastal subarea W-2. The level of impact on coastal wetlands in the WCA resulting from the proposed action is estimated to be low.

(2) Impacts on Sensitive Offshore Habitats

As described in Section IV.D.2.a.(3), the major potential impact producing factors that could affect the biota of the topographic features in the Western Gulf are oil spills; blowouts; anchor, rig, platform, and pipeline emplacement; and discharge of drilling fluid. Oil and gas operations resulting from the proposed action could cause very high and potentially long-lasting damage due to the relatively small coral and coral community areas of the Gulf (especially the East and West Flower Garden Banks) if unrestricted operations take place on or near these important sensitive habitats. High deleterious impacts to fish habitats of the topographic features may also affect the recreational and commercial fisheries of the area, and the intrinsic biological, ecological, and aesthetic values of these areas might be seriously diminished.

The proposed stipulation described in this section would preclude nearly all of the adverse impacts from the routine oil and gas operations. The topographic features stipulation would mitigate impacts resulting in a very low level of impact to the biota of the sensitive topographic features.

(3) Impacts on Water Quality

(a) Offshore

As a result of Sale 112, localized offshore water quality degradation will occur in the WPA. Immediate impacts would be brought on by increased drilling of up to 216 exploration and delineation wells, 276 development wells, construction, and pipelaying activities resulting from the laying of up to 250 miles of pipeline. Other impacts would stem from additional dredging activities and discharges of drilling muds, fluids, cuttings, sanitary and domestic wastes, and formation waters from the 23 platforms projected for this area. The expected impacts are estimated to be high around platforms and construction sites depending on existing local water conditions, with the extent of such impacts extending from only a few meters to tens of meters from these sites. These impacts will decrease to very low with distance (500-1,000 m) from the source. The overall impact to offshore water quality is estimated to be low.

(b) Onshore

Onshore water quality degradation will occur as a result of increased nonpoint and point sources of pollution, especially in those areas of Texas (Sabine Pass to Lavaca Bay) where water quality problems persist. Any increased point source impacts from a new service base in W-1 (1) or W-2 (1) can be mitigated by Federal and State regulations and guidelines. The construction of up to 40 miles of onshore pipeline in coastal subareas W-1 (20) and W-2 (20) will create nonpoint source increases in surface runoff; however, these nonpoint sources may be minimized by controlling erosional effects generated within construction site boundaries. Impacts to onshore water quality are expected to be low.

(4) Impacts on Air Quality

Sale 112 is expected to impact air quality from activities such as catastrophic events (blowouts and oil spills), offshore operational emissions as a result of drilling, platform installation, and production activities. Impacts are assumed to be felt in areas classified as nonattainment or PSD Class I areas that are adjacent to more OCS-related activities, i.e., Cameron, Nueces, Galveston, Jefferson, Brazoria, and Harris Counties in Texas. Coastal air quality could deteriorate if an unflared blowout caused the uncontrolled release of sour gas (high H_2S content) into the atmosphere near shore. The expected levels of OCS related activities (20 platforms and no new gas processing or refining facilities) should cause little long-term degradation of ambient air quality with no significant effects on nonattainment or PSD areas. (For a detailed analysis, see Section IV.D.2.a.(4).) Short-term degradation of air quality could occur as a result of the uncontrolled release of sour gas from a blowout. Overall impacts on air quality are expected to be moderate in any coastal area near an uncontrolled sour gas blowout. Low impacts are expected in Cameron, Nueces, Galveston, Jefferson, and Brazoria Counties, Texas. Very low impacts are expected throughout the remainder of the coastal area in the Western Gulf.

(5) *Impacts on Endangered and Threatened Species*

The impact producing factors which could affect endangered and threatened species as a result of the proposed action in the WPA include OCS-related oil spills, collision with offshore support vessels, and disturbance from onshore construction.

(a) Brown Pelicans

There is about a 3% probability of one or more oil spills occurring and contacting pelican feeding and nesting habitat in Brazoria County, Texas; other pelican habitat has less than a 0.5% chance. Two service bases and two pipelines requiring a total of about 242 acres in Calhoun or San Patricio Counties (subarea W-1) and in Matagorda, Brazoria, or Jefferson Counties (subarea W-2) in Texas are unlikely to affect brown pelicans and their habitats in these areas. The expected level of impact on brown pelicans is estimated to be very low.

(b) Marine Mammals (Whales)

There is a low probability of one or more oil spills occurring and contacting deepwater areas off the continental shelf where whales occur. Low levels of spill contacts are expected to result in a very low level of impact. Offshore support vessel traffic is estimated to increase in this coastal area and is not likely to impact whales. The disturbance and noise associated with seismic exploration and drilling of about 216 exploration and delineation wells will be short-term and localized near drilling sites. The expected level of impact on whales is estimated to be very low.

(c) Sea Turtles

There is less than a 1% probability of one or more oil spills occurring and contacting sea turtle nesting habitat along southwestern Padre Island and a 9% probability of one or more oil spills occurring and contacting sea turtle foraging areas along the Texas and Louisiana coasts. Offshore support vessel traffic into the Texas ports is not estimated to increase; currently, it is about 2% of the annual vessel traffic in the WPA and is not likely to impact sea turtles. Two service bases and two pipelines requiring a total of about 242 acres in Matagorda, Brazoria, Calhoun, San Patricio, or Jefferson Counties in Texas are unlikely to affect the occasional sea turtle nesting in these counties. The expected level of impact on sea turtles is estimated to be low.

(6) *Impacts on Coastal and Marine Birds*

The impact producing factors which could affect coastal and marine birds as a result of this proposed action in the WPA include offshore-related oil spills and disturbance from onshore construction. The highest probability of an oil spill occurring and contacting coastal and marine bird habitat is 9% in Galveston County, Texas. This low probability of oil spill occurrence indicates a low chance of an oil spill resulting from the proposed action to impact coastal and marine birds in the WPA. Two service bases and two pipelines requiring a total of about 242 acres in Calhoun, San Patricio, Matagorda, Brazoria, Galveston, Chambers, or Jefferson Counties in Texas are unlikely to affect coastal and marine birds and their habitats in these areas. The expected level of impact on coastal and marine birds in the Western Gulf is estimated to be very low.

(7) *Impacts on the Commercial Fishing Industry*

Several impact producing factors from this alternative could affect the commercial fishing industry, including loss of fishing area through construction of platforms/structures, gear conflicts, and an offshore oil spill greater than 1,000 bbls. As a result of these impact producing factors, a moderate impact (a 1% or less economic loss to the commercial fishing industry, some financial loss to the fishermen, and secondary employment affected) could occur to the commercial fishing industry.

(8) Impacts on Major Shorefront Recreational Beaches

There is a 12% probability that one large (1,000 bbls or greater) and several smaller oil spill contacts with major shorefront recreational beaches could occur. Such spill contacts could be with Padre Island National Seashore or Galveston Island, causing temporary closure of the impacted areas to beach recreational use. Residuals, such as trash and debris associated with offshore operations, will inadvertently wash up on major recreational beaches and chronically detract from the aesthetics of beach use causing localized, short-term inconveniences and add to the maintenance problem of recreational beach administrators. The overall expected level of impact on major shorefront recreational beaches is estimated to be moderate.

(9) Impacts on Archaeological Resources

(a) Historic

The impact producing factors which would affect offshore and onshore historic sites include interactions with drilling rigs, platforms, pipelines, anchors, construction of onshore facilities, and contact by spilled oil. Should an interaction between one of these impact producing factors and an historic site occur, significant or unique historic information could be lost. Although the potential for such an interaction occurring is uncertain, if there is an interaction, there is potential for a high to very high impact.

The lease stipulation, if adopted, would reduce the potential for a very high impact to very low by allowing sites to be located prior to interaction occurring, thereby making avoidance or mitigation of impacts possible. The exception to the lease stipulation's effectiveness is in subplanning area W-1 where the potential for a very high impact level would not be significantly reduced because of thick unconsolidated sediments which make the magnetometer the primary instrument for shipwreck detection. At 150 m linespacing the magnetometer provides only 25%-30% coverage of the survey area.

(b) Prehistoric

All of the impact producing factors which could affect offshore and onshore historic sites could affect prehistoric sites as well. Should an interaction between one of these impact producing factors and a prehistoric site occur, significant or unique archaeological information could be lost. Although the potential for such an interaction occurring is uncertain, if there is an interaction, there is potential for a high to very high impact.

The lease stipulation, if adopted, would reduce the potential for a very high impact to very low by allowing potential site areas to be located prior to interaction occurring, thereby making avoidance or mitigation of impacts possible.

c. Proposed Mitigating Measures

(1) Topographic Features Stipulation

The topographic features of the Western Gulf provide habitat for coral and coral community organisms (Section III.B.2.). As discussed in Section IV.D.2.a.(3), these communities would be severely and adversely impacted by unrestricted oil and gas activities resulting from the proposed action if such activities took place on or near these communities. DOI has recognized this problem for some years, and since 1974 stipulations have been made a part of leases on blocks on or near enough to these biotic communities for the oil and gas activities to have an impact on these communities. It should be noted that this stipulation would not prevent the recovery of oil and gas resources, but it would serve to protect valuable and sensitive biological resources.

The topographic features stipulation was developed by a DOI workshop of MMS and FWS biologists. Comments were solicited from Federal and State agencies, industry, academia, and interested environmental groups.

The stipulation would establish No Activity Zones at the topographic features. The zone is defined by the 85 m isobath because, generally, the biota shallower than 85 m are more typical of the Caribbean reef biota, while the biota deeper than 85 m are similar to soft bottom organisms found throughout the Gulf. Where a bank is in water depths less than 85 m, the deepest closing isobath defines the No Activity Zone for that bank. Within the No Activity Zone, no operations, anchoring, or structures would be allowed.

Outside of the No Activity Zones, additional restrictive zones would be established within which oil and gas operations could occur but within which drilling discharges would be shunted.

The stipulation generally would require that all effluents within 1,000 m of the south Texas banks, which contain the Antipatharian-transitional zone, be shunted to within 10 m of the seafloor. The shelf edge banks, which contain the more sensitive and productive algal-sponge zone, would require a shunt zone extending 1 nmi and a 3 nmi shunt zone for development only.

Exceptions to this general stipulation scheme would be made at two classes of banks: the Flower Gardens and the low relief banks. The Flower Gardens, because they contain the northernmost example in the Gulf of living coral reefs and are being considered for National Marine Sanctuary status (Section I.B.6.a.), would be protected to a greater degree than the other banks. The added provisions of the stipulation at the Flower Gardens would be that: (a) the "No Activity Zone" would be based on the 100 m isobath instead of the 85 m isobath and would be defined by the "1/4 1/4 1/4" system (a method of defining a specific portion of a block) rather than the actual isobath; and (b) there would be a "4 Mile Zone" instead of a "1 Mile Zone" in which shunting would be required.

The second exception would be for the low relief banks where shunting is considered counterproductive because it would put the potentially toxic drilling muds in the same water zone as the bank biota that are being protected. Because of their low relief, these banks are adapted to high turbidity. Therefore, these banks would contain only a "No Activity Zone." Claypile Bank is a low relief bank which is categorized as a Category B bank because it contains the *Millepora*-sponge community. Because of its higher priority it would be given the added protection of a "1,000 Meter Zone" in which monitoring would be required. Since shunting would be counterproductive, monitoring was chosen as a means of assuring that effluent discharge within 1,000 m of this high priority, low relief bank would not affect the biota of Claypile Bank.

The banks to which this stipulation would be applied to blocks in the Western Gulf are:

Bank Name	Isobath (meters)	Bank Name	Isobath (meters)
Shelf Edge Banks		Low Relief Banks[2]	
West Flower Garden Bank[1]	100 (defined by 1/4 1/4 1/4 system)	Mysterious Bank	74, 76, 78, 80, 84 (see leasing map)
East Flower Garden Bank[1]	100 (defined by 1/4 1/4 1/4 system)	Blackfish Ridge	70
MacNeil Bank	82	Big Dunn Bar	65
29 Fathom Bank	64	Small Dunn Bar	65
Rankin Bank	85	32 Fathom Bank	52
Geyer Bank	85	Coffee Lump	Various (see leasing map)
Elvers Bank	85		
Bright Bank[5]	85	Claypile Bank[3]	50
McGrail Bank[5]	85		
Rezak Bank[5]	85	South Texas Banks[4]	
Sidner Bank	85		
Parker Bank	85	Dream Bank	78, 82
Stetson Bank	62	Southern Bank	80
Applebaum Bank	85	Hospital Bank	70
		North Hospital Bank	68
		Aransas Bank	70
		South Baker Bank	70
		Baker Bank	70

[1] Flower Garden Banks - In paragraph (c), a "4 Mile Zone" rather than a "1 Mile Zone" applies.

[2] Low Relief Banks - Only paragraph (a) applies.

[3] Claypile Bank - Paragraphs (a) and (b) apply. In paragraph (b) monitoring of the effluent to determine the affect on the biota of Claypile Bank shall be required rather than shunting.

[4] South Texas Banks - Only paragraphs (a) and (b) apply.
[5] Central Gulf of Mexico bank with a portion of its "1 Mile Zone" and/or "3 Mile Zone" in the Western Gulf of Mexico.

The stipulation reads as follows:

Topographic Features Stipulation
(Western Planning Area)

(a) No structures, drilling rigs, pipelines, or anchoring will be allowed within the listed isobath ("No Activity Zone") of the banks as listed above.

(b) Operations within the area shown as "1,000 Meter Zone" shall be restricted by shunting all drill cuttings and drilling fluids to the bottom through a downpipe that terminates an appropriate distance, but no more than ten meters, from the bottom.

(c) Operations within the area shown as "1 Mile Zone" shall be restricted by shunting all drill cuttings and drilling fluids to the bottom through a downpipe that terminates an appropriate distance, but no more than ten meters, from the bottom. (Where there is a "1 Mile Zone" designated, the 1,000 Meter Zone in paragraph (b) is not designated.)

(d) Operations within the area shown as "3 Mile Zone" shall be restricted by shunting all drill cuttings through a downpipe that terminates an appropriate distance, but no more than ten meters, from the bottom.

Effect of the Lease Stipulation

The wording of the topographic features stipulation has developed over the past 11 years in consultation and coordination with FWS and USGS. In addition, advice has been received from other agencies, such as USEPA and NMFS, as well as from industry and other interested groups. The wording has exhibited changes which reflected new information received on the biology of the sensitive offshore habitats.

The stipulation wording is based on the scientific information collected over the past 11 years. This information includes various Bureau of Land Management/MMS-funded studies on the topographic highs in the Central Gulf; numerous stipulation-imposed, industry-funded monitoring reports; and the National Academy of Science (NAS) report entitled Drilling Discharges in the Marine Environment (1983). Based on this collection of information, biologists from the Department of the Interior (MMS and FWS) agreed that the proposed stipulation better reflects the current body of scientific knowledge.

The stipulation was formulated based on consultation with various Federal agencies and comments solicited from State, industry, environmental organizations, and academic representatives.

The rationale for the requirements in the stipulation are based on the following facts:

(a) Shunting of the drilling effluent to the nephloid layer contains the effluent to a level deeper than the level of the living reef of a high relief topographic feature. Shunting is therefore an effective measure for protecting the biota of high relief topographic features. (Bright and Rezak, 1978; Rezak and Bright, 1981; and NAS, 1983.)

(b) Biological effect on the benthos from the deposition of unshunted discharge is mostly limited to within 1,000 m of the discharge (NAS, 1983).

(c) The biota of topographic features can be categorized into depth-related zones defined by degree of reef building activity (Rezak and Bright, 1981 and Rezak et al., 1983).

The stipulation would protect the sensitive portions of the reef from physical damage due to oil and gas operations by the establishment of "No Activity Zones." Mechanical damage is probably the single most severe impact to benthic areas resulting from oil and gas operations. A "No Activity Zone" would completely eliminate this threat to the area within the zone.

The stipulation would protect the low relief banks, except Claypile Bank, with only a "No Activity Zone." The biota of these banks and the turbidity of the water is such that protective measures for the drilling discharges are not warranted. However, mechanical damage to the banks from drilling and anchoring could significantly impact these resources. The "No Activity Zone" would protect the banks of these impacts.

The stipulation has an added measure of protection for Claypile Bank, a low relief bank. The stipulation would require a no activity zone and a 1,000 m zone in which monitoring would be required. Claypile Bank is presently the only low-relief bank which is known to be inhabited by the *Millepora*-sponge community. This assemblage is categorized by Rezak and Bright (1981) as Category B community, a zone of minor reef-building activity worthy of increased protection. Due to the low relief of the bank (only 5 m), shunting would be counterproductive. Therefore, a "1,000 Meter Zone" in which monitoring is required would be imposed. Any impacts from drilling would thereby be documented so that further protective measures could be taken.

The stipulation would require that all effluents within 1,000 m of a high relief topographic feature categorized by Rezak and Bright (1981) as a Category C bank be shunted. The banks would be protected from impact from drilling discharges within the 1,000 m zone because the potentially harmful materials in drilling muds are trapped in the bottom boundary layer and do not get upon the bank where the biota of concern are located. Surface drilling discharge at distances greater than 1,000 m from the bank is not expected to impact the biota since effects are mostly limited to 1,000 m.

The stipulation would protect the remaining Category A and B banks with greater restrictions. (Applebaum Bank is categorized as a C bank; however, it contains the algal sponge community which is indicative of Category A banks and is, therefore, stipulated as a Category A bank.) Surface discharge would not be allowed within 1 nmi of these more sensitive banks. Thus, the stipulation would prevent impacts to the biota of these sensitive banks from drilling discharges within 1 nmi. Surface discharges outside of 1 nmi are not expected to impact the biota of the banks as effects from surface discharges are mostly limited to 1,000 m. However, it is possible that extremely small amounts of muds discharged more than 1 nmi from the bank may reach the bank. In order to eliminate the possible cumulative effect of muds discharged from numerous wells outside of 1 nmi, the stipulation would impose a "3 Mile Zone" in which shunting of development effluent would be required.

The stipulation would require increased protection to the Flower Gardens out to four miles. Shunting would be required within a "4 Mile Zone." This is a measure proven effective near topographic features. The stipulation would prevent damage to the biota of the banks from the oil and gas activities resulting from the proposal. Furthermore, oil and gas resources present near such areas could be recovered. However, the stipulation would not protect the banks from the adverse effects of an accident, such as a large blowout on a nearby oil or gas operation. Fortunately, blowouts are rare in the Gulf.

(2) Archaeological Resource Stipulation

The archaeological resource stipulation is identical for the Central and Western Gulf, and applies to all blocks leased. See Section II.A.1.c.(3) for the stipulation and a discussion of its effect.

(3) Military Areas Stipulation

The military areas stipulation is identical for the Central and Western Gulf and applies to all blocks leased within a warning area. See Section II.A.1.c.(4) for the stipulation and a discussion of its effect.

d. Notice to Lessees and Operators (NTL) 83-3 Concerning Shallow Hazards for the Gulf of Mexico OCS Region

NTL 83-3 is identical for the Central and Western Gulf. A discussion of NTL 83-3 is in Section II.A.1.d. and the NTL itself comprises Appendix B.

e. Proposed Information to Lessees on the Gulf Ocean Incineration Site

In order to minimize the conflicts between OCS activities and the incineration of hazardous wastes in the USEPA designated incineration site in the Western Gulf, the following Information to Lessees (ITL) is proposed:

> Bidders are advised of the existence of the Gulf Ocean Incineration Site located in the East Breaks, Garden Banks, Alaminos Canyon, and Keathley Canyon leasing areas. This site is designated for the incineration of organohalogen wastes, including polychlorinated biphenyls and ethylene dichloride. Lessees are advised to contact the USEPA, Washington, DC office when formulating plans for undertaking oil and gas activity in the designated incineration site area so that potential conflicts can be mitigated through coordination of activities. The following blocks are affected by the Gulf Ocean Incineration Site:

East Breaks	Garden Banks
1008	969-981
1009	

Alaminos Canyon			Keathley Canyon	
40	260	480	1-12	353-364
41	261	481	45-56	397-408
84	304	524	89-100	441-452
85	305	525	133-144	485-496
128	348	568	177-188	529-540
129	349	569	221-232	573-584
172	392	612	265-276	617-628
173	393	613	309-320	
216	436	656		
217	437	657		

Effect of the Proposed Information to Lessees

The ITL would allow the coordination of activities between oil and gas activities and incineration uses. Through notification of USEPA of proposed drilling activities, the lessee/operator and USEPA could schedule activities so as to avoid conflict.

2. Alternative B - No Action

a. Description of the Alternative

The alternative is equivalent to cancellation of a sale scheduled for a specific timeframe on the approved 5-Year OCS Oil & Gas Leasing Schedule. Sales in the Western Gulf are scheduled on an annual basis. Therefore, the opportunity is postponed or foregone for development of the estimated 0.13 billion bbls of oil and 1.87 tcf of gas that could have resulted from this sale in the Western Gulf. This no action alternative would be contrary to our National goal of expediting development of our domestic resources as a means of lessening our dependence on foreign oil.

b. Summary of Impacts

All impacts, positive and negative, associated with the proposed action (as discussed in Section IV.D.2.a.) would be cancelled and the importation of foreign oil at present or increased levels would be continued. There would be an increased environmental risk of oil spills caused by tankering the oil. Adverse socioeconomic impacts could include loss of employment opportunities, payroll revenues, and tax revenues. The economic stability of the coastal region could be negatively affected. Also, see Section IV.D.2.c. for a discussion of the development of alternative energy supplies as replacement sources for lost domestic production. Table IV-32 presents replacement energy equivalents for the estimated resources for this sale.

3. Alternative C - Delete Biologically Sensitive Offshore Habitats

The deletion alternative is offered for the Secretary's consideration to protect valuable offshore biological resources. It affects the biologically sensitive banks of the Western Gulf.

All of the blocks included in the deletion alternative are also the blocks which would be covered by the biological stipulations (discussed in Section II.B.1.c.(1) which can be adopted by the Secretary to protect the biological habitats of these areas. Furthermore, the Secretary could choose to adopt only a part of the alternative, either alone or in conjunction with the proposed biological stipulation, in order to promote the environmental protection policies of the Department.

a. Description of the Alternative

This alternative would delete the 56 unleased blocks of the total 200 blocks which are on or near biologically sensitive areas of topographic features in the Western Gulf. This deletion alternative is presented as an environmental protection measure. The blocks that could be deleted under this alternative are the same as those referred to in Section II.B.1.c.(1) above and are listed in Appendix A.

b. Summary of Impacts

Selection of this alternative would serve to protect the sensitive high value coral communities of the Western Gulf from the potential harm resulting from oil and gas activities emanating from leases issued at this proposed sale. All other impacts of this proposed action would be unchanged. (See Section IV.D.2.c. for a full discussion of the impacts of this alternative.) Furthermore, deletion of all these blocks would provide nearly full protection for the biota of these areas, while the biological stipulation of Section II.B.1.c.(1) would provide further control and reduce the potential impacts to very low but it would not remove all risk.

4. Comparison of Alternatives

Table S-3 provides a comparison and summary of the impact levels of the proposed action (Alternative A), no action (Alternative B), deletion of biologically sensitive offshore habitats (Alternative C), and the cumulative analysis for Sale 112. The definitions of the level of impact used are in Table S-4.

Alternative A, the proposed action, has the potential to result in very low, low, or moderate impacts on all resource categories of concern with the exception of topographic features and archaeological resources. The biological, archaeological resources, and military areas stipulations are being considered for adoption as mitigating measures. These resources are expected to have very high levels of impact (if the proposed stipulations are not in effect). If the proposed stipulations are utilized, the levels of impact would be reduced to very low for these resources, except for historic shipwrecks in the western portion of the Western Gulf where the level of impact is still expected to be very high.

Alternative B, no action, would preclude any impacts to the resource categories listed in Table S-3 from the proposed action or other alternatives.

Alternative C, deletion of biologically sensitive offshore habitats, would preclude any impacts to topographic features and would have the same levels of impact as Alternative A for the remainder of the resource categories listed in Table S-3.

SECTION III

DESCRIPTION OF THE AFFECTED ENVIRONMENT

III

III. DESCRIPTION OF THE AFFECTED ENVIRONMENT

A. PHYSICAL ELEMENTS OF THE ENVIRONMENT

1. Environmental Geology and Hazards

a. Geology

The Texas and Louisiana shelf and slope are characterized by rapid rates of sedimentation into massive accumulations of silts, and clays, and numerous sand deposits in buried channels and small basins between uplifted domes. The area is absent of any major regional structures. However, thousands of smaller diapiric structures are present to influence the stratigraphy, sediment basin locations, and channel deposits.

The prospective horizons of the northwestern continental shelf are of Miocene, Pliocene, or Pleistocene age. The environment of deposition of the continental shelf and slope in the northern Gulf of Mexico is one of the most significant factors controlling hydrocarbon production. Sediments deposited on the outer shelf and upper slope have the greatest potential for bearing hydrocarbons due to the following reasons: (1) This is the location where nearshore sands interfinger with the deeper-water marine shales providing an optimum ratio of sandstone to shale. The shale may be the source rock that provides the oil and gas while the sandstone provides the reservoir into which the hydrocarbons migrate and are trapped; (2) In this environment, the organic material deposited with the fine-grained clays and muds is preserved, and not oxidized as it might be in shallower, more turbulent water; and (3) It is at this location that the increased overburden of the prograding shallow marine deposits over the plastic salt and marine shales initiates the salt flow that triggers the growth of salt domes and regional expansion faults which in turn provide traps for the hydrocarbons.

This environment, therefore, is the optimum zone for encountering the three ingredients necessary for the successful formation and accumulation of oil and gas: reservoir rock, source beds, and traps.

Offshore Louisiana sediments of Miocene and Pliocene ages are overlain by a thicker section of Pleistocene sediments derived from the Mississippi River system. The Texas shelf, during Pleistocene time, received smaller volumes of sediment because it was on the western border of the Mississippi River depocenter.

Since production of oil and gas frequently occurs along the continental shelf-slope break, the progradation of the north-central Gulf depositional regime has resulted in the migration of this production zone seaward and in the development of a series of progressively younger producing trends.

Future Pleistocene production from the upper continental slope region (200-1,000 m water depth) adjacent to the Texas-Louisiana OCS now appears probable with many discoveries recently announced in deeper waters. The continental slope includes all of the relatively steeply sloping seabed from the shelf edge to the abyssal floor. The prospective horizon of the upper slope may consist of a thin section of Miocene and Pliocene overlain by a thick section of Pleistocene age. The Pleistocene sediments are considered the most prospective reservoir beds. The structural grain and hummocky topography of the slope are controlled primarily by salt tectonics. Virtually the entire province is underlain by gigantic salt stocks and swells.

Basinal areas between salt structures of the upper slope contain a thickness of as much as 3,500 m of sediment, most of which appear to be muddy, slump deposits with infrequent turbidite sand zones. It has been speculated that turbidite sands of reservoir quality could be present on the upper slope, especially in deposits of Pleistocene age.

b. Geologic Hazards

Within the Gulf of Mexico, major geohazards to oil and gas development are associated with seafloor geologic features which result in seafloor instability. Primarily, the hazards are produced by: (1) increased gradient at the edge of the continental shelf where it merges with the continental slope; (2) regional high rates of deposition on the continental shelf that cause isostatic adjustments and deep-seated gravity faulting; (3) local high rates of unconsolidated sediments deposited on the increased gradient of the continental shelf edge that has led to intensive slumping and mudslides; (4) diapiric movement of low density material through overlying sediment that has caused extensive deformation, the damming of sediments, gravity faulting, and slumping; and (5) high biogenic gas content in rapidly deposited sediments.

c. Non-Oil and Non-Gas Mineral Resources

Several minerals in the Central Gulf of Mexico now are, or have the potential to become, commercially exploitable. Deposits of quartz sand in Federal and State waters off the coasts of Mississippi and Alabama are of interest because of their potential use in the production of glass. Sulphur and salt deposits associated with the thousands of diapiric and domed structures in the OCS seafloor have mining potential. Although there are five active leases in OCS waters, none of these leases are currently producing, and a new sulphur or salt lease has not been issued since 1967. Presently, supplies onshore and within State waters preclude the future development of OCS deposits.

In the Western Gulf of Mexico there are no known nonpetroleum mineral resources presently of interest or of economic value.

2. Meteorological Conditions

General Description

The Gulf of Mexico and adjacent coastal areas are part of the Atlantic tropical cyclone basin, which is one of six such geographical areas on the earth influenced by tropical cyclones. It is also a region where other types of meteorological phenomena occur. Because of its extensive coastal region and almost complete enclosure by land, the Gulf is, also a favorable region for the development of atmospheric disturbances associated with land and sea surface temperature contrasts. As population and industrialization increases in hurricane prone areas, the assessment of risk of damage is important for planning purposes. Since the unpredictability of hurricane events precludes a stable climatological summary of the risk of storm recurrence at any one locality, the probability of occurrence may be used. Based on climatological averages it is a standard procedure and a reliable guide (USDI, BLM, 1980).

Pressure, Temperature, and Relative Humidity

The western extension of the Azores-Bermuda high pressure cell dominates circulation throughout the year, weakening in winter and strengthening in summer. The average monthly pressure reaches a minimum of 1,014-1,106 millibars from west to east over the northern Gulf during the summer, but attains a maximum of 1,021 millibars during the winter. The minimum average monthly pressure occurs during the summer when the equatorial trough shifts northward; however, the maximum pressure occurs during the winter as a result of the presence and influence of continental cold air.

Average temperatures at coastal locations vary with latitude and exposure. In winter they depend on the frequency and intensity of penetration by polar air masses from the north. These incursions, when they bring strong northerly winds, are called "northers" and may occur some 15-30 times between November-March.

Air temperatures over the open Gulf exhibit narrower limits of variations on both a daily and seasonal basis. The average temperature over the center of the Gulf is about 29°C in the summer; winter temperatures average between 17°-23°C.

The relative humidity over the Gulf is high throughout the year, Minimum humidities occur during the late fall and winter when cold, continental air masses bring dry air into the northern Gulf. Maximum humidities occur during the spring and summer when prevailing southerly winds bring in warm, moist air. The recording stations from Brownsville, Texas, to Key West, Florida, shows the relative humidity varies annually from a high of 87% at 6:00 a.m. to a low of 44% at 12 noon. This variation in a six-hour period is caused by daily warming.

Surface Winds

Winds are more variable near the coast than over open waters because coastal winds are more directly influenced by the moving cyclonic storms that are characteristic of the continent and because of the sea and land breeze regime. The Azores-Bermuda atmospheric high pressure cell dominates circulation over the Gulf, particularly during the spring and summer months. In late summer there is a general northward shift of the circulation, and the Gulf becomes more directly influenced by the equatorial low pressure cell. During the relatively constant summer conditions, the southerly positions of the Azores-Bermuda cell generates predominantly southeasterly winds which become more southerly in the northern Gulf. Winter winds usually blow from easterly directions with fewer southerlies but more northerlies. Winds from the west and southwest are rare at anytime during the year.

Precipitation and Visibility

Average annual precipitation along the Gulf coast ranges between approximately 69 cm at Brownsville, Texas; 102 cm at Galveston, Texas; and 137 cm at New Orleans. Rainfall is fairly evenly distributed throughout the year, with the greatest amounts occurring during June, July, and August when the winds are predominantly out of the south and southeast. This does not imply a continuity of precipitation for the South Texas region.

Precipitation is frequent and abundant throughout the year but does show distinct seasonal variation. At New Orleans, October is the only month when precipitation averages less than 8 cm; July is the wettest month and receives just under 18 cm. Stations along the entire coast record the highest precipitation values during the warmer months of the year. The warmer months usually have convective cloud systems which produce showers and thunderstorms; however, these thunderstorms rarely cause any damage or have attendant hail (USDC, 1967 and Brower et al., 1972). The month of maximum rainfall for most locations is July, however, Brownsville's record maximum is in September. Winter rains are associated with the frequent passage of frontal systems through the area. Rainfalls are generally slow, steady and relatively continuous, often lasting several days. Snowfalls are rare, and when frozen precipitation does occur it usually melts upon contact with the ground. Incidence of frozen precipitation decreases with distance offshore and rapidly reaches zero.

Warm, moist Gulf air blowing slowly over chilled land or water surfaces brings about the formation of fog. Fog occurrence decreases seaward but visibility has been less than one half mile due to offshore fog. Coastal fogs generally last three or four hours, although particularly dense sea fogs may persist for several days. Poorest visibility conditions occur during winter and early spring. The period from November-April has the highest frequencies of low visibilities. On the South Texas coast, fog reduces visibility to less than five eighths of a mile on an average of 28 days/year; very dense fog in Galveston reduces visibility to three eighths of a mile about 16 days/year; and Port Arthur has an average of 42 days/year with visibility less than three eighths of a mile. Visibility around the Mississippi Delta may be lowered by industrial pollution from New Orleans or burning marshlands.

Severe Storms

Hurricanes vary considerably in intensity, track patterns, and behavior when crossing land. McGowen et al. (1970), explains that storm approach is marked by rising tides and increased wind velocities; generally, the longer a storm lingers in the Gulf, the larger the surge of water it pushes ashore as it approaches land. These storm tides are commonly higher in the bays than on Gulf sea beaches, although flooding and pounding waves affect both areas. There is no preferred approaching route of hurricane tracks (DeWald, 1980), although early season storms generally approach from the southeast while later ones are more out of the south. Most hurricanes form in tropical ocean areas: however, a few are generated in the Gulf of Mexico. From 1901-1971, seven hurricanes and seven tropical storms formed in the Gulf north of 25°N and east of 85°W.

Hurricane damage results from high winds and, particularly in the coastal areas, the storm surge or tide which is an abnormally high rise in the water level (Visual No. 6). Maximum surge height at any location is dependent on many factors including bottom topography, coastline configuration, and storm intensity. The storm surge associated with Hurricane Betsy in 1965 reached nearly 6.1 m (20 ft) at Bayou Lafourche; however, Hurricane Carla in 1961 produced 7 m (23 ft) tides in Lavaca Bay, Texas. Hurricane Camille, the most severe hurricane in recent Gulf history, attained top winds estimated at 324 km/hr with barometric pressure in her eye as low as 68 cm (26.6 in) of mercury and in late August 1977, Hurricane Anita came ashore just south of the United States border in Mexico after tracking through the Gulf and bringing storm surges to various parts of the Texas and Louisiana coasts. Hurricane Babe, just strong enough to be termed a hurricane, developed three days later, but caused no significant offshore damage when it came ashore near Morgan City, Louisiana. For a synopsis of 1985 hurricanes, see Appendix D.

The largest and most destructive storms affecting the Gulf of Mexico and adjacent coastal zones are tropical cyclones which have their origin over the warm tropical waters of the central Atlantic Ocean, Caribbean Sea, or southeastern Gulf of Mexico. Tropical cyclones occur most frequently between June and late October, and there is a relatively high probability that they will cause damage in the Gulf each year. These storms, categorized according to intensity and relative probability of occurrence in certain coastal areas, are discussed in the BLM Open File Report

80-02 (USDI, BLM, 1980). In addition, the determination of storm intensity at sea (Visual No. 6) is often difficult, especially from the older records. Therefore, statistics for hurricanes and tropical cyclones are often lumped together.

Extratropical cyclones originate in middle and high latitudes forming on the fronts that separate different air masses. These storms which may vary greatly in intensity occur primarily during the winter months and have attained wind speeds as great as 55-93 km/hr. The Gulf of Mexico is an area of cyclone development during the cooler months due to the contrast in temperatures of the warm air over Gulf waters and the cold continental air over the United States. These storms rapidly dissipate after entering the Gulf of Mexico.

3. Physical Oceanography

The Gulf of Mexico is a subtropical sea with an area of approximately 1.6 million km^2. Its continental shelf ranges in width from about 350 km offshore West Florida to about 20 km off the Mississippi River. The depth of the central abyss ranges to 4,000 m. The various physiographic regions of the Gulf basin were shown on Visual No. 9 of Final EIS 94/98/102.

The Gulf is unique among the world's mediterranean seas, having two entrances: the Yucatan Strait and the Straits of Florida. It also contains a portion of the Gulf Stream system, the parent Loop Current, whose presence and influence will be described below. Around the 15,500 mile Gulf coastline 21 major estuaries are found on the U.S. coast, and a number of rivers--dominated by the Mississippi River--provide sufficient freshwater input so that the basin is classified a positive estuary.

The Loop Current is a highly variable current feature entering the Gulf through the Yucatan Strait and exiting through the Straits of Florida after tracing an arc that may intrude as far north as the Mississippi-Alabama shelf. The Loop consists of ascending and descending 30-km wide bands of rapidly moving water enclosing a relatively quiescent inner region, and the entire feature may clearly be seen in hydrographic sections down to about 1,000 m. Below that level there is evidence of a counter-current. The volumetric flux of the Loop has been estimated at 30 million m^3/sec. Velocities up to 300 cm/sec have been measured, but a range of 100-200 is probably representative.

The "location" of the Loop Current is definable only in statistical terms, due to its great variability. Figure G-7 of Appendix G shows the relative existence probabilities for Loop Current water throughout the Eastern Gulf in March, the month of apparent greatest intrusion. Values range from a 100% core location at 25°N, down to small probabilities (10%) near midshelf. Figure G-8 of Appendix G shows the results of a "wave staff" analysis, where observed Loop front locations along selected meridional lines are analyzed for central tendency, range, and dispersion. An average northern intrusion is indicated to 26.6°N, within a wide envelope. Both analyses exclude the period June-October, however, due to limitations on satellite data.

The process responsible for the first-order variability of the Loop is the shedding of anticyclonic eddies, which may occur when the current is greatly extended. The usual eddies are large, necessitating significant dimensional adjustment by the Loop, clearly seen in the data of Figure G-9 of Appendix G. The eddy-shedding cycle has earlier been the subject of much field work and currently of numerical modeling. Based on these data, Figures G-1, G-2, and G-3 of Appendix G have been prepared to illustrate the overall cycle, including the subsequent behavior of the eddies. Figure G-4 of Appendix G displays the long-term mean surface circulation over several eddy cycles.

Processes responsible for smaller, or second-order variability of the Loop, include persistent wind forcing, shelf-edge interactions along the Yucatan Shelf and West Florida Shelf, and waves along the Loop front associated with the eddy cycle. These waves may grow into large intrusions of warm Loop water onto the adjacent shelf, or intrusion of colder shelf water into the Loop itself as seen in Figure G-10 of Appendix G. Collectively, these processes set up a zone of Loop Current fluctuation covering the outer shelf, the slope, and abyssal areas off Mississippi, Alabama, and Florida (MAFLA).

Major Loop Current eddies have diameters on the order of 300-400 km and may clearly be seen in hydrographic data to about 1,000 m. Swirl velocities within the eddies have been reported from 50-200 cm/second. As seen in Figures G-5 and G-6 of Appendix G, they move into the Western Gulf along various paths to a region between 25°N-28°N and 93°W-96°W. The eddies move at a speed of about 5 km/day, decreasing in size as they mix with resident waters. The life cycle of an individual eddy, to its eventual assimilation by regional circulation patterns in the Western Gulf, is about one year.

The eddy-shedding behavior of the Loop is the principal mechanism coupling the circulation patterns of the eastern and western parts of the basin. The heat and salt budgets of the Gulf are dependent on this importation, balanced by seasonal cooling and river input, and probably also by internal, deeper currents that are poorly understood. They may be evident in intriguing hints of abyssal bottom scour and the reversed currents beneath the Loop itself. The eddies are frequently observed to affect local current patterns along the Louisiana/Texas slope, hydrographic properties, and possibly the biota of fixed platforms. There is some evidence that these large reservoirs of warm water play some role in strengthening tropical cyclones when their paths coincide.

Smaller anticyclonic eddies have been observed to be generated by the Loop Current, although it is not known if the process is merely a scaled-down version of the above cycle. They have diameters on the order of 100 km, but the few data available indicate a shallow hydrographic signature, on the order of 200 m. Their observed movements indicate a tendency to translate westward along the Louisiana/Texas slope. Some are included in the analysis presented in Figure G-6 of Appendix G. Similar in size, cyclonic eddies are observed in the Eastern Gulf, associated with the eddy-shedding cycle, and along the Louisiana/Texas slope. Their genesis and role in the overall Gulf circulation are not well studied. A major cyclonic eddy seems to be resident in the southwestern Gulf, based on older data synthesis, but some recent evidence points toward a more complex, less homogeneous structure.

Aside from the wind-driven surface layer, current regimes on the outer shelf and slope are the result of balance between the influence of open Gulf circulation features, such as the Loop and eddies, and the shelf circulation proper, which is dominated by long-term wind forcing. Offshore Northern Mexico and South Texas, a western boundary current occurs, driven both by prevailing winds and the semipermanent anticyclonic eddy. A strong east-northeasterly current along the remaining Texas and Louisiana slope has been explained partly by the effects of the semipermanent cyclonic eddy and a partner cyclonic eddy ("modon pair") and partly by the mass balance requirements of eddy movement. Within the Loop Current fluctuation zone, offshore the MAFLA states, the intrusion of the Loop front or the presence of minor detached eddies sets up short-term strong currents, but no permanent current has been identified other than a weak statistical residual. When the Loop Current impinges onto the Florida slope and shelf, it has been observed that the current structure acts to upwell nutrient-rich water from deeper zones, a mechanism which may also take place as eddies move along the Louisiana/Texas slope or semipermanently in the zone identified in Figure G-6 of Appendix G, accounting for increased productivity recognized in these areas.

On the Texas shelf a confluence of northeasterly moving water from the south with southeasterly moving water from the Louisiana shelf has been recognized. The convergence zone appears to move seasonally, but the complete cycle has not been exhaustively studied. On the Mississippi/Alabama shelf the winter circulation is frequently a westward flow. During the summer, this flow is reduced or may reverse. On the West Florida shelf the currents are predominantly south in all seasons, with the suggestion of a weak cyclonic gyre in the northeastern corner.

Sharp discontinuities at the sea surface, such as the Loop Current front or fronts associated with eddies or river plumes, are dynamic features in themselves which may act to concentrate buoyant material such as spilled oil or plankton. The principal movement of these materials, however, is not in the direction of gross translation of the front, such as Loop Current incursion or the slow westward drift of eddies. The lateral motion along the front predominates such motion by about an order of magnitude and removal along this orientation is the expected outcome rather than a simple "pushing" of the material in a direction normal to the front. In addition to open ocean fronts, a coastal front is probably a permanent feature of the Gulf shelf, separating turbid, lower salinity water from the open shelf regime. Figure G-18 of Appendix G indicates that the front lies about 30-50 km offshore. It is not known how strongly this front might effect buoyant material transport.

Figures G-11 through G-14 of Appendix G show the seasonal mean winds from a multi-year analysis. An annual cycle of wind direction is indicated: winter winds from the east-northeast; spring winds from the southeast; summer winds from the southeast and south; and fall winds shifting back to the east-northeast. The distribution of wind speeds is shown in Figure G-17 of Appendix G. Western summer winds have a mode at 4-6 m/sec, compared to 2-4 m/sec in the Eastern Gulf. Winter winds are stronger in both regions, principally in the 8-10 m/sec interval, which may be due to cold fronts transiting the southeastern United States every 3-10 days in the fall and winter.

Not reflected in the wind climatology are the much stronger winds associated with tropical cyclones that frequently move through the greater Caribbean area. The classes of cyclones, and their defining minimum wind speeds, are as follows: tropical depression (up to 16 m/sec); tropical storm (17-31 m/sec); and hurricane (32 m/sec or more). Figure G-15 of Appendix G gives the probabilities that at least one cyclone in the storm or hurricane categories will occur in a defined zone in a given year.

A summary of significant wave height measurements is presented in Figure G-17 of Appendix G based on a multi-year analysis. Western summer waves tend to be smaller than those in the Eastern Gulf; waves in both regions intensify in winter, with the Western Gulf showing a clear mode at 2-3 m. Not reflected in these results are the much larger waves associated with hurricanes. Figure G-16 of Appendix G displays the hindcast significant wave heights for several hurricanes since the onset of offshore development, indicating a range of about 20-40 ft for open shelf waves. Also displayed are expected 100-year maximum waveheights, which could range to 70+ ft.

Sea surface temperatures in the Gulf, as shown in Figures G-19 through G-23 of Appendix G, range from a nearly isothermal 29°-30° in August, to a sharply developed gradient in January, ranging from 25° in the core of the Loop to values of 14°-15° along the shallow northern coast estuaries. August temperatures at 150 m show a warm Loop Current and an anticyclonic feature in the Western Gulf (both about 18°-19°) grading into surrounding waters of 15°-16° along the slope. The entire pattern is maintained during winter, but warmer by about 1°. At 1,000 m the temperature remains close to 5° year-round.

4. Chemical Oceanography

The discussion which follows heavily emphasizes hydrography and the productivity aspects of classical chemical oceanography. Process-oriented material is not presented, as no unique mechanisms are known to prevail in the Gulf of Mexico. Trace metal information is not discussed, with one exception, since either the earlier data simply cannot be used, due to recently recognized inaccuracies in older methodologies, or the recent data show no notable trends.

The Gulf has been the subject of a number of regional or basin-scale studies emphasizing chemistry of the water column, and of several valuable reviews. The material synthesized below derives from the following sources, organized into a chart to assist the reader in further reading:

		Central Gulf		Western Gulf	
Reference	Gulf-Wide	Nearshore	Offshore	Nearshore	Offshore
Barnard and Froelich, 1981	x				
Barrett et al., 1971		x			
Caillouet et al., 1981				x	
Caruthers, 1972	x				
Christmas and Eleuterius, 1973		x			
Corcoran, 1973	x				
El-Sayed et al., 1972	x				
El-Sayed and Turner, 1977	x				
Flint and Rabalais, eds., 1980				x	x
Gallaway, 1981		x	x	x	x
Iverson and Hopkins, 1981	x				
McGrail et al., 1978					x
Middleditch, 1981				x	
Nowlin, 1972	x				
Southwest Research Institute, 1981		x	x		
Ward et al., eds., 1979		x			
Williams, 1954	x				

Regional Overview

Due to the ambience of the medium, space scales far greater than those considered relevant in biological considerations apply to chemical oceanographic assessment. Water mass characterizations are generally applicable at scales on the order of 1,000 km, while processes related to meso-scale circulation patterns, such as primary production, probably should be described in terms of 100-km scales. For these reasons, the following description is organized to proceed from greater to lesser scales as the emphasis shifts from nearly conservative basin-wide characteristics to regionally variable, inshore/offshore parameters.

Circulation Patterns

The Gulf of Mexico is a semiclosed system with oceanic input through the Yucatan Channel and principal outflow through the Straits of Florida. Runoff from approximately two-thirds of the area of the United States and more than half the area of Mexico empties into the Gulf. This large amount of runoff with its nonoceanic composition is mixed into the surface water of the Western Gulf and makes the chemistry of parts of this system quite different from the open ocean.

The surface current patterns and deepwater spreading in the Gulf of Mexico are largely determined by topography. Water enters from the Caribbean over the 1,800 m sill of the Yucatan Channel and leaves through the Straits of Florida with a sill depth of 600 m. This major current feature, transporting about 30 million m^3/sec, generally penetrates into the Gulf to about 26°N before looping back to the south, hence its name, the Loop Current. Although it was earlier believed that the Loop exhibited an annual cycle of increased penetration culminating in the detachment of a warm-core eddy in late summer/early fall, a great deal of interannual variability has been recorded. It has been asserted that the Loop Current's mean annual cycle is forced by cycles of mass transport, current location and direction, and/or vorticity through the Yucatan Strait and outflow through the Straits of Florida. How the rest of the open Gulf receives the greater part of its energy is still unclear. The abyssal circulation is virtually unknown. Shelf regions, which constitute a large portion of the Gulf, have only recently received some attention, possibly because of their complexity and in spite of their economic importance.

Mixed Layer Hydrography

Salinity: The mixed layer, extending down to a depth of approximately 100-150 m, is characterized by salinities between 36.0 o/oo and 36.5 o/oo in the open Gulf. Salinity values in shelf regions may vary widely from this range due to the opposing effects of river input and enhanced evaporation. Alternating floods and droughts may cause salinity changes from nearly fresh to 100 o/oo, three times that of normal sea water. These variations can lead to mass mortality of marine organisms.

Temperature: In the Eastern Gulf, maximum surface temperatures range from 27°C in late winter to about 30°C in the summer. A range of 22°-29°C is observed in the Western Gulf, the difference reflecting the contribution of the Loop Current. Lowest values encountered may range as low as approximately 10°C in the Louisiana-Mississippi shelf region owing to extraordinary snow melt in the upper Mississippi Valley.

Oxygen: Dissolved oxygen values in the mixed layer average about 4.6 ml/L, with certain seasonal variation, particularly a slight lowering during the summer months. Oxygen values generally decrease to about 3.5 ml/L with depth through the mixed layer.

Subsurface Water Mass Hydrography

Subtropical Underwater (SUW): This water mass occurs throughout the Gulf, characterized by a salinity maximum just less than 36.8 o/oo at depths between 100 and 300 m, coincident with a temperature of about 23°C. Oxygen values average about 3.6 ml/L at the salinity maximum, decreasing with depth through the water column.

18° Sargasso Seawater (18°SSW): This water mass has only recently been identified in the Gulf. Its characteristic temperature, 17.3°C, is somewhat less than its namesake source water in the Sargasso Sea. A small oxygen maximum is found in the upper part of the broad oxygen minimum associated with the next deeper water mass. The core salinity is typically 36.3 o/oo, usually found at depths of 200-400 m.

Antarctic Intermediate Water (AAIW): This water mass is identified by both oxygen and salinity minima, and an intermediate nutrient maximum (see below). The water occurs at depths of 500-1,000 m with typical salinities and temperatures in the core (salinity minimum) of 34.6-34.9 o/oo and 6.3°C, respectively. An oxygen minimum is usually located about 200 m above the salinity minimum, with values from about 2.0-2.5 ml/L. Maxima for the nutrients phosphate, nitrate, and silica occur at a level midway between these minima.

Gulf Basin Water: This water mass, lying below the Yucatan sill depth of about 1,500 m, is composed principally of North Atlantic Deep Water (NADW). Below 1,500 m, this water shows an almost constant potential temperature of 4.1°C and a salinity of 34.97 o/oo. Oxygen values increase slightly to a maximum of about 4.5 ml/L.

Information provided by Morrison (Proceedings . . ., 1982, p. 154) on hydrographic characteristics of Western Gulf deep water has increased our knowledge of water masses. This information is summarized in Table III-1.

Table III-1

Water Property Extremes in the Gulf of Mexico

Water Mass	Extreme	Concentrations	Depth Range (m)	Location
Gulf Water	Salinity maximum	36.4-36.5 ppt	0-250	Gulfwide
Subtropical Underwater (SUW)	Salinity maximum	less than 36.8 ppt	100-300	Eastern Gulf*
18° Sargasso Seawater (18° SSW)	Oxygen maximum	(small and variable)	200-400	Eastern Gulf*
Tropical Atlantic Central Water	Oxygen minimum	2.5-2.9 ml/l	250-400	Gulfwide
Antarctic Intermediate Water	Nitrate maximum	29-35 ug-at/l	500-700	Gulfwide
Antarctic Intermediate Water	Phosphate maximum	1.7-2.5 ug-at/l	600-800	Gulfwide
Antarctic Intermediate Water	Salinity maximum	34.88-34.89 ppt	700-800	Gulfwide
Mixture of North Atlantic Deep Water and Caribbean Mid-Water	Silicate maximum	24-28 ug-at/l	1,000-1,100	Gulfwide

*SUW may occasionally be found in the Western Gulf in eddies detached from the Loop Current. There have also been indications of 18° SSW in detached eddies, but the evidence is slight.

Exotic Waters

Hypersaline Basins: Two basins containing hypersaline waters have been identified. Salinities as high as 196 $^{o}/oo$ at a small pool on the East Flower Garden topographic high and 250 $^{o}/oo$ in the Orca Basin have been measured. Unique geochemical regimes may be present at these sites, due to the partial absence of oxygenated chemical species.

Midshelf Freshwater Vents: At a number of sites on the southwest Florida shelf, submarine springs are present, being found in association with extensive karst topography. Little is known about the chemical regime or the associated biota within these features.

Micronutrients

Nutrient Cycling: The principal micronutrients about which generalizations can be drawn, based on the limited data available, are phosphate, nitrate, and silicate. Phytoplankton consume phosphorus and nitrogen, principally via their ionic species, in an approximate ratio of 1:16 for growth. Silicon is consumed for production of skeletal structures. Mineralization of dead plankters returns the nutrients to the water column, although typically at a greater depth than that of initial assimilation, due to sinking.

Mixed Layer Distribution Patterns: Phosphates range from 0-0.25 ppm, averaging 0.021 ppm. Shelf values do not differ significantly from open Gulf values. Integrated Eastern Gulf values are somewhat lower than Central and Western Gulf values. Silicates range predominantly from 0.048-1.9 ppm. Open Gulf values tend to be lower than shelf valves. Integrated Eastern Gulf values are again somewhat lower than Western Gulf values. Nitrates range from 0.0031-0.14 ppm, averaging 0.014 ppm. Open Gulf values are slightly higher than shelf values. There is no clear pattern in depth-integrated values between regions.

Vertical Distribution: Vertical distribution of nutrients show five general features related both to the identified water masses and to biological activity: (a) low concentration in the mixed layer (to 100 or 200 m); (b) substantial increase from 200 m to 700 or 800 m; (c) maximum values at approximately 800-1,000 m; (d) small decreases in concentration below 1,000 m; and (e) homogeneous concentrations below about 1,500 m. At the maxima, phosphate concentrations range from 0.14-0.23 ppm, silicates from 1.9-2.3 ppm, and nitrates from 1.8-2.1 ppm.

Particulate and Optical Parameters

Biological primary production in the Gulf is critically dependent on both chemical and physical factors. The driving photosynthetic mechanism is light-limited, and, due to attenuation processes in the water column, is ineffective below an average depth of about 75 m, where incident light has been reduced to 1%. The most highly variable component of total light field attenuation in the water column is the scattering induced by suspended particles, both organic and inorganic. Particles also act as substrates for bacterial activity, transport loci for absorbed species, and as physical irritants to sensitive biological species. Open Gulf waters have particle contents ranging from about 0.1-0.2 ppm. Over 50% of the suspensate is organic in surface waters, decreasing to about one-third in deeper waters. The inorganic fraction is composed largely of clay minerals, reflecting the importance of the Mississippi River as a source.

A common phenomenon in the Gulf, especially on the shelf, is the local presence of greatly elevated suspensate concentrations, with values about 1 ppm. Typically, near-bottom layers of near homogeneous scattering values are encountered, separated from overlying waters by sharp discontinuities. These "nepheloid" layers may be associated with resuspension by swift-flowing bottom current, with intense at-depth biological activity, or with a complex combination of both factors. These features appear to occur naturally at nearly all locations on the shelf and upper slope environment, excepting the promontories of significant topographic highs.

Primary Production

Productivity Measurements

Regional Distribution: Primary production, the rate of synthesis of the organic constituents of plant material in water, commonly estimated by C^{14} uptake, occurs predominately at the level of 0.25 mgC/m^3/hr, or less, throughout the Gulf. Higher levels, between 0.25 and 1.0 units, are found at northeastern and southern locations, with maximum values on the Yucatan shelf. In terms of depth-integrated values, western regions seem to be more productive than the eastern regions. It should be noted that open water C^{14} techniques may underestimate actual production.

Depth Distribution: Higher productivity levels are sustained at subsurface levels rather than at the surface. Maximum C^{14} assimilation generally occurs at depths corresponding to 50%-25% of surface lights intensity.

Seasonal Distribution: Unlike temperate or high latitude waters where the amplitude of the seasonal variations in productivity is manifold, the amplitude in the Gulf is very much damped. The ratio of maximum (winter) to minimum (spring) integrated productivity is approximately 2:1.

Chlorophyll Measurements

Regional Distribution: The distribution of chlorophyll closely parallels that of productivity. Most values range from 0.05 to 0.30 mg/m^3 (ppb), with highest values found off the Mexican coast. In terms of depth-integrated values, the region of the Loop Current seems to show higher values for chlorophyll than the Central and Western Gulf.

Depth Distribution: Maximum chlorophyll concentrations occur very deep within the portion of the water column where the lights exceeds 1% of surface insulation, the euphotic zone. In some cases maxima are found below the euphotic zone, possibly reflecting sinking plankters. Secondary peaks of chlorophyll above the maximum may be associated with thermal gradients in the water column.

Seasonal Distribution: Maximum (winter) depth integrated values for chlorophyll exceed minimum (fall) values only by a factor of about 1.2.

Total Production

Average depth-integrated primary productivity in the Gulf is about 0.1 gC/m^2/day, for an annual production of 17 gC/m^2. This value is about one-half of one available estimate for all the world's seas, and one-half to one-fourth the value for the western central Atlantic. Annual total production for the Gulf is about 43 million metric tons of carbon. Assuming a carbon content of 50% in the biomass, a gross annual production of 86 million metric tons can be calculated. This estimate agrees well with an annual fisheries harvest on the order of one million metric tons, as two orders of magnitude should classically separate these trophic levels. The agreement is possibly fortuitous, as the considerable organic input from estuarine and fluvial sources, as well as a host of complex recycling processes, are ignored.

a. Central Gulf of Mexico

Estuarine and Inner Shelf

Hydrography and Nutrient Chemistry: This area is strongly influenced by the presence of America's major river, the Mississippi, as well as a host of other major drainage systems. A complex geography of sounds and bays protected by barrier islands and extensive tidal marshes acts to delay mixing, resulting in extensive areas of mesohaline (middle salinity) conditions. Turbidity is normally quite high, with suspended sediments up to 1-10 mg/1, primarily composed of clay minerals. The salinity gradients established in estuarine areas are extremely important for maintenance of finfish and shellfish production, and enormous fluctuations in harvest may occur, paralleling annual hydrology.

In general, Louisiana's estuaries and near offshore waters are low in salinity and high in nutrient concentrations as compared with other states bordering the northern Gulf. These characteristics are due primarily to Louisiana's high rainfall and the large volume of river water which makes its way through rich alluvial soils to the Gulf of Mexico. The major contributors of nutrients to the estuaries are the Mississippi and Atchafalaya Rivers.

Within the nearshore area, sediment trace metal values may show high absolute concentrations or anomalous ratios due to the input of contaminated clays borne by the Mississippi. Transition metals known to be used/disposed of during heavy industrial processes, such as mercury and cadmium, are likely contaminants.

The Mississippi River input acts to create a lens of fresher, more turbid water, often curling to the west. Hydrographic studies, suspended sediment characteristics, and sensitive chemical analyses demonstrate its influence as far west as South Texas. Of importance is the water-column stratifying effect of this fresh lens on nearshore waters. It is frequently observed during summer months that anoxic bottom water conditions exist on the central Louisiana shelf. Mass mortality of organisms and characteristic chemical changes also occur. These conditions have serious implications for monitoring programs of any sort.

Primary Production: As a probable consequence of the large fluvial input of nutrients, the Louisiana nearshore shelf is considered one of the most productive areas of phytoplankton in the Gulf. Integrated chlorophyll values are two times average Gulf values, and integrated production values range an order of magnitude greater than the Gulf average.

Outer Shelf and Slope

Hydrography and Nutrient Chemistry: Less is known about the nature of offshore waters in the central area than in other zones. Observations indicate that the effects of the Mississippi are felt here, although much reduced by distance. Anoxic bottom waters are not reported, although surface freshening occurs at times of maximal discharge. Upwelling of cooler, nutrient-rich waters onto the shelf is known, but the mechanism is not fully understood since regional circulation patterns remain unclear. The passage of detached, anticyclonic eddies toward the west may be important in this regard. The water column is frequently observed to contain turbid layers associated with interfaces between two or three distinct water layers. A Mississippian origin is suggested for these layers.

Primary Production: No studies have been identified which characterize this specific region. It is believed that values for productivity and chlorophyll approach Gulf averages, but that circulation events, such as the transient effects of passing eddies, might play a role in enhancing these values.

b. Western Gulf of Mexico

Estuarine and Inner Shelf

Hydrography and Nutrient Chemistry: Nutrient concentrations are generally representative of open Gulf surface waters, but continental run-off influences nearshore surface concentrations, especially in spring. Nutrients are reduced to extremely low values after spring and summer blooms, but are replenished in the fall.

The water column over the inner shelf is very nearly isothermal during the fall, winter and spring months, showing a slight stratification only in summer. Temperatures characteristic of the mixed layer over the inner Texas shelf range from approximately 11°-13°C in late winter to 28°-29°C in late summer. Salinities range from open Gulf surface values of about 36.4 o/oo to 20 o/oo or less during the spring run-off or during heavy rainfall. A bottom nepheloid layer is nearly always observed.

Primary Production: Chlorophyll is highly correlated with salinity decreases in this area, indicating the influence of riverine input. The local input from Texas rivers is the major source of freshwater nutrients and turbidity in the region. These effects decrease with distance from shore. Most chlorophyll is found at the bottom of the water column, from the shore out to midshelf.

Outer Shelf and Slope

Hydrography and Nutrient Chemistry: Beyond the nearshore region of heavy influence by Texas rivers, the effects of the Mississippi River are felt. Although salinity variations are seen to respond to Mississippian input, nutrients do not correspond as closely, due perhaps to some depletion during transit. Overall, the nutrient values are somewhat lower than inshore values. The intrusion of nutrient-rich, oxygen poor water from apparent depths of 200-300 m is indicated in many cases, with effects seen all the way up to 70 m depth. An area of major upwelling has been indicated along the shelf break.

Primary Production: Productivity on the outer shelf exhibits much less variability, which can be ascribed to riverine input. Chlorophyll values in this area average less than inshore areas, as expected, but an inverse relation with salinity is not found. Aperiodic upwelling events are probably of primary importance in regulating offshore production in this area.

5. Water Quality

Water quality is based upon numerous factors, including currents, freshwater inputs, nature and number of discharges, outfalls, and human activities that consist of municipal and industrial waste discharges, runoff, oil spillage, dredging, etc. In the past, water quality has been defined as the degree to which chemical concentrations and physical parameters within a water mass approach the ambient water state. Table III-2 illustrates the range of values for water quality parameters measured in the Gulf of Mexico off Texas and Louisiana. Offshore water quality degradation in the Gulf of Mexico is associated primarily with effluent discharges by current offshore enterprises, consisting of OCS activities and marine transportation sources. As of January 1983, some 15,871 wells had been drilled in Federal waters off Louisiana, while 1,695 wells were drilled off Texas. Production from these wells equated to some 6 billion bbls of oil/condensate and 56.8 tcf of gas off Louisiana and 89 million bbls of oil/condensate and 5.2 tcf of gas off Texas (USDI, MMS, 1984d). Potential discharges associated with these past exploration/production activities equate to some 8.9 million yd^3 of drill cuttings, 79.9 million bbls of drilling muds, and up to 5.48 billion bbls of formation waters. Historically, the highest concentration of oil and gas activity has taken place within an area south of Timbalier Bay, Louisiana, eastward to an area some 20 miles east of the Mississippi River Delta. This area extends offshore to the south for some 75 miles. Within this area, produced water discharges alone have ranged from 0.5 million to greater than 1.5 million gallons/square mile/year (USDC, NOAA, 1985). Coastal or onshore water quality varies and is determined by river outflows into the Gulf, primarily the Mississippi River. The Mississippi River has the greatest impact on the Gulf's water quality and is the most significant source of pollution to this area. The existing water quality of the coastal regions of the Gulf is briefly discussed below. For a more detailed discussion of water quality, see Volume 1, Section III.C.10. of the Final Regional EIS. See also Figure III-1 for areas of concern with respect to water pollution within the Central and Western Gulf coastal areas.

Central Gulf of Mexico

The Central Gulf region is characterized by many water quality problems that are affected by the discharge or release of industrial wastes and domestic sewage into its rivers, bays, and estuaries. The most significant source of pollution in this area is the outflow from the Mississippi River which drains more than 5.5 Mkm^2 or 41% of the lands of the continental United States. This drainage results in the presence of high bacterial concentrations and toxic pollutants within the Mississippi River area and is evidenced by high levels of organic pollutants found in its deltaic sediments. Other contributions to water quality problems within this region stem from increased land clearing activities associated with agriculture, industry and urbanization, dredging and disposal of dredge material, and industrial/domestic pollution from numerous point source discharges along the coast. These activities have led to the eutrophication of several coastal water bodies in Louisiana and the permanent and temporary closure of many shellfisheries in the region.

Western Gulf of Mexico

The Texas coastal area has been plagued with numerous water quality problems in the past. Degradation of water quality has occurred from many sources, including domestic and industrial effluents, dredging operations, agricultural runoff, shipping, offshore operations, etc. The majority of these water quality problems occur in the Houston-Galveston and Beaumont-Port Arthur areas where the majority of Texas' energy facilities are located. Utilization of the Houston ship channel and the Sabine-Neches River complex as effluent receiving systems has seriously impacted the water quality of these systems and the surrounding areas. However, an effort has been made in the last several years to clean up these systems with an upgrade of industrial and municipal waste treatment systems, hence lessening the water quality degradation experienced in the past. Although the area between Sabine Pass and Lavaca Bay has been beset by numerous water quality problems, the majority of Texas coastal river basins exhibit acceptable water quality (Texas Water Quality Board, 1976 and Texas Department of Water Resources, 1983).

Table III-2

Range of General Water Quality Values for Offshore Freeport, Texas, and West Louisiana Coastal Waters

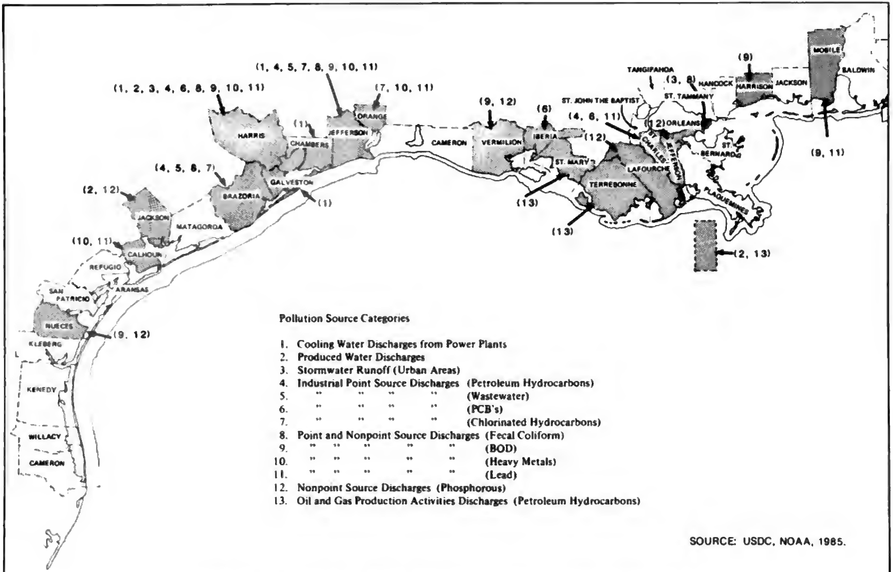
Parameters	Bryan Mound Predisposal Study[1]	SEADOCK (1973)[2]	West Louisiana Coast (1978-1979)[3]
S ^{o}/oo	16.1-36.9	15.1-33.6	–
T (°C)	10.5-31.5	11.1-30.6	–
pH	7.2-8.7	7.8-8.4	–
D.O. (mg/l)	1.1-10.3	0.2-10.9	–
O&G (mg/l)	< 0.5-23.4	< 0.3-2.6	–
TSS (mg/l)	< 0.1-264	5-85	–
NO_2-N (mg/l)	<0.01-0.04	<0.01-0.07	<0.001-0.013
NO_3-N (mg/l)	<0.01-0.67	<0.01-0.14	<0.001-0.15
NH_3-N (mg/l)	<0.01-0.10	<0.01-0.29	0.004-0.22
O-PO_4 (mg/l)	<0.01-0.10	–	0.01-0.13
T-P (mg/l)	<0.01-0.12	< 0.1-0.74	–
SiO_2 (mg/l)	<0.05-4.2	–	0.17-2.4

Other Parameters[4]

Na	10,500 mg/l
K	380 mg/l
Ca	400 mg/l
Mg	1,350 mg/l
Cl	19,000 mg/l
I	0.06 mg/l
Br	65 mg/l

[1] Texas A&M Research Foundation, 1980.
[2] SEADOCK, 1975. (Eight stations nearest present study area.)
[3] Brooks, 1979.
[4] Riley and Skirrow, 1965.

Source: Texas A&M Research Foundation, 1980.



Pollution Source Categories

1. Cooling Water Discharges from Power Plants
2. Produced Water Discharges
3. Stormwater Runoff (Urban Areas)
4. Industrial Point Source Discharges (Petroleum Hydrocarbons)
5. " " " " (Wastewater)
6. " " " " (PCB's)
7. " " " " (Chlorinated Hydrocarbons)
8. Point and Nonpoint Source Discharges (Fecal Coliform)
9. " " " " " (BOD)
10. " " " " " (Heavy Metals)
11. " " " " " (Lead)
12. Nonpoint Source Discharges (Phosphorous)
13. Oil and Gas Production Activities Discharges (Petroleum Hydrocarbons)

SOURCE: USDC, NOAA, 1985.

AREAS OF CONCERN WITH RESPECT TO POINT AND NONPOINT SOURCE POLLUTION WITHIN THE CENTRAL AND WESTERN GULF OF MEXICO

Figure III-1

6. Air Quality

Air quality of the coastal area along the Gulf of Mexico is measured against the National Ambient Air Quality Standards (NAAQS) resulting from the Clean Air Act, as amended. These standards are designed to preserve the air quality of an area at a threshold necessary to protect public health and welfare.

The ambient air quality in any area is determined by utilizing special monitoring schemes (40 CFR 50) and is measured relative to NAAQS' primary and secondary standards. Primary standards are designed to protect public health, and secondary standards are designed to protect public welfare. If a county or section of a county does not meet the primary and/or secondary standards, they are classified as nonattainment. Areas designated as Prevention of Significant Deterioration areas are identified as mandatory Class I Federal Areas where visibility is an important value. These areas are national and international parks and wilderness areas.

Air quality in the coastal region of the Gulf is generally considered good and in many areas is better than the national standards. The Eastern Gulf of Mexico is coastal in the State of Florida. Of the 22 coastal counties, 19 are clean air counties. Three counties exceed standards for ozone (O_X). Of these three counties, one also exceeds primary and secondary standards for sulfur oxides (SO_X) and another exceeds the secondary standards for Total Suspended Particulates (TSP). The Central Gulf of Mexico is coastal in the States of Alabama, Louisiana, and Mississippi. Of the two Alabama counties fronting the Central Gulf, one is a clean air county. The other county exceeds primary standards for O_X and both primary and secondary standards for TSP in the urban center. Of the three coastal counties in Mississippi, all are clean air counties. Of the 14 coastal parishes in Louisiana, 7 are clean air parishes. Seven parishes exceed primary standards for O_X. The Western Gulf of Mexico is coastal in the State of Texas. Of the 16 coastal counties, 10 are clean air counties. One county exceeds primary standards for TSP, and five counties exceed primary standards for O_X. Of these five, two also exceed standards for TSP.

PSD Class I areas are located in two of the five Gulf coastal states: Florida and Louisiana. In Florida there are three PSD areas, and in Louisiana there is one. All five states have State Implementation Plans for air quality coupled with regulatory enforcement and monitoring programs in operation.

Ambient air quality is considered to be a function of the size, distribution, and activity of a population and, more importantly, the industrialization of an area. Emissions from all sources, such as external combustion, solid waste incineration, internal combustion, evaporation, chemical processing, etc., make up the ambient air quality at any given time according to the particular rates of emission, proximity of emission sources, local meteorological conditions, and the rate of dispersion. These factors preclude the ambient air quality from remaining the same at all times and, in fact, work in unison such that peak and low conditions are observed as a function of time; i.e., at certain periods the controlling factors may cause the ambient air quality to meet or exceed NAAQS and at other times it may be far below. Meteorological conditions play a very important role in the dispersion of emissions, and thus, on the ambient air quality. Generally, long-range transport of emissions will cause worst-case onshore conditions when a plume is traveling in a stable layer (strong inversion) over water, when the winds are persistent in reaching shore, and when unstable daytime conditions occur over coastal areas. These conditions are rare in the coastal Gulf regions due primarily to prevailing climatological and physiological characteristics.

B. BIOLOGICAL RESOURCES

1. Coastal Habitats

The following habitats are characteristic of the northern Gulf of Mexico coast: forested wetlands, non-forested wetlands, mangroves, barrier bays, seagrass beds, and barrier islands. The habitats are discussed in the general order of occurrence beginning inland and proceeding to the Gulf. These habitats may occupy narrow bands or large areas and can consist of sharply delineated zones of different plant communities, monotypic stands of single species, or mixed plant species communities.

Forested wetlands are usually the inland band of habitat and extend from the uplands to the non-forested wetlands. Forested wetlands consist of moist to saturated soils supporting mixed forest and scrub shrub communities. The hydrologic pattern ranges from permanently flooded to seasonally flooded, usually in response to associated river systems and tidal fluctuations. The topography is flat and a very slight change in elevation results in changes in plant and animal communities. Predominant trees are bald cypress, tupelogum, ash, oaks, elms, and numerous shrubs. Forested wetlands provide feeding, nesting, and wintering habitat for migratory and nonmigratory birds.

Non-forested wetlands occur seaward from forested wetlands and landward from open bays. The topography is flat, soils saturated, and plant communities consist of emergent grasses, forbs, shrubs, and a few trees. Predominant plants are marsh cordgrasses, rushes, sedges, arrowheads, several fleshy halophytes on the exposed soil and eelgrass, widgeon grass, and wild celery in open water. Trees and shrubs include oaks, groundsel tree, wax myrtle, and buttonbush. The hydrologic regime ranges from permanently flooded to seasonally flooded in response to associated river systems and tidal fluctuation. These wetlands are interlaced with bayous, rivers, small ponds, and slight ridges. Non-forested wetlands are among the most productive habitats on earth because of the combination of fertile alluvial soils, periodic flooding and dewatering, fresh to saline conditions, and extensive exposure to sunlight.

Non-forested wetlands provide habitat for a wide variety of finfish, shellfish, birds, mammals, and herpetofauna. These wetlands are extremely important nursery areas for the brown shrimp, white shrimp, spotted seatrout, red drum, flounder, gulf menhaden, and Atlantic croaker. These wetlands are the major producers of finfish and shellfish harvested commercially and for sport in the estuarine zone of the Gulf. Birds, including herons, egrets, ibises, migratory ducks, geese, and rails, are heavily dependent on these wetlands for wintering habitat. Non-forested wetlands are the principal site of duck and goose hunting along the Gulf coast. Furbearing mammals, including the nutria, river otter, mink, and muskrat, occur in and are commercially harvested from the wetlands.

Mangroves usually occur seaward from forested and non-forested wetlands and landward from open bays and barrier islands. There are an estimated 4.5×10^5 acres of mangroves along the Gulf coast, the largest proportion occurring in the Eastern Gulf. Four species occur along the Gulf coast: red, black, and white mangroves and buttonwood. Black mangroves are found intermittently from the southern tip of Florida to coastal mid-Florida and along the coast of Louisiana and Texas. About 2,200 acres of black mangroves occur along the Louisiana shoreline. Mangroves exhibit a zonation of species, with reds generally found in deepest waters along shorelines; landward are black mangroves and buttonwoods. White mangroves are the least abundant species and generally grow landward of black mangroves (Thayer and Ustach, 1981).

The open bays and associated passes occur seaward from the non-forested wetlands and landward from the barrier islands. Open bays are shallow bodies of estuarine water ranging in salinity from near sea strength in fall to slightly brackish in spring and winter. Water bottoms range from coarse sand to fine clays and silts; some are colonized with submerged vegetation. The open bays are interconnected with passes, bayous, and rivers, and are often bordered on the seaward side by barrier islands. Open bays are extremely important production and harvest areas for white shrimp, brown shrimp, spotted seatrout, red drum, flounder, and American oyster. These areas are heavily used by migratory waterfowl, principally diving ducks, gulls, terns, skimmers, and numerous species of less abundant shorebirds. Open bays are a major site of recreational fishing, boating, and swimming.

Seagrass beds are generally located between barrier islands and the non-forested wetlands in shallow open water. Seagrasses can also occur in some inlets between barrier islands, and in the Eastern Gulf seagrasses occur in some nearshore and offshore areas. They consist of rooted aquatic vegetation that may or may not extend to the water surface. Predominant plant species are shoal, turtle, and widgeon grasses and wild celery. Seagrass beds provide nursery, feeding, and escape habitat for many species of finfish, shellfish, and microorganisms. Migratory waterfowl, principally diving ducks, feed over seagrass beds. Manatees and green turtles also occur in seagrass areas.

Barrier islands are located along the seaward edges of open bays. These islands are long sandy beaches with dunes, a few trees, and limited non-forested wetlands. Barrier islands are the initial beachfront contact of wave action from the Gulf. The islands extend from several feet to less than a mile in width and from a few hundred yards to 100 miles in length. Most of them do not rise more than 10-15 ft above sea level. Wave, wind, and tidal forces shape the barrier islands. Beaches and dunes migrate in response to fluctuations in seasonal and cyclic wave patterns, storms, and hurricanes.

The flora and fauna of the typical Gulf coast barrier island is diverse. On the coastal side of these islands, non-forested wetlands supporting marsh cordgrasses, saltwort, and sea oxeye are found. On the Gulfside, dune vegetation including sea oats, saltgrass, and groundsel tree are present. Further inland, several species of pines and oaks may be present. Barrier beaches provide habitat in the form of nesting, feeding, and resting areas for many species of shorebirds, wading birds, and seabirds. Some Gulf barrier beaches, primarily in the Eastern Gulf, provide nesting habitat for sea turtles.

The habitats described above are categorized for descriptive purposes. Ecologically and biologically the interaction of these habitats within the coastal zone is important. No habitat category functions independently of another and any alteration of one probably has an impact on the others.

Collectively, the coastal zone of the Gulf of Mexico is one of the most productive habitats in the world. The central source of this productivity is the forested and non-forested wetlands. Table III-3 outlines the acreage of habitats along the coast.

Table III-3

Habitat Acreage for the Central and Western Analysis Areas

	Planning Areas	
Habitat	Central	Western
Forested Wetlands	981,493	73,418
Non-Forested Wetlands	3,393,695	875,245
Mangroves	2,200	0
Bays	2,606,180	1,638,265
Seagrass Beds	72,068	290,919
Barrier Islands	42,836	194,650

a. Barrier Beaches/Islands

Barrier islands, spits, and bay barriers are subcategories of the overall geomorphic category called barrier beaches. Bay barriers are connected to headlands on both ends. Barrier spits are attached to a source of sediment but can be converted into islands by inlet severance of this connection. Barrier islands are bounded on each side by inlets without attachments to the mainland. In many cases a small barrier spit can develop on the flanks of a barrier island (Leatherman, 1982).

Barrier beaches (islands and spits) are a common landform along the Gulf Coast and stretch in an irregular chain from Florida to Texas. These elongated, narrow landforms are composed of sand and other loose sediments transported by waves, currents, storm surges, and wind. In geological terms, barrier islands are a young phenomenon, being formed only in the last 5,000 to 6,000 years. The term "barrier" identifies the structure as one that protects other features, such as bays, estuaries, and marshes, from direct wave attack of the open ocean. The waters in these bays and estuaries are a blend of the terrestrial-freshwater systems of the mainland and the saltwater system of the ocean, and among the richest ecosystems known. Many of the species that inhabit the bays, estuaries, and adjacent marshes use these areas as spawning, nursery, and feeding grounds. It is estimated that "two thirds of the top-value Atlantic and Gulf Coast species of fish are directly dependent in some stages of life on conditions of these estuaries" (Clark, 1976).

Another benefit of both the islands and their adjacent marshes and bays is that of providing habitats for a large number of birds and other animals. The islands also provide habitat for several threatened or endangered species, for example, the loggerhead turtle, the southern bald eagle, alligators, and brown pelicans.

Barrier beaches are dynamic, relatively low land masses that often lead to conflict with human development. The shoreline is in constant flux, eroding or accreting in concert with changing energy conditions. These landforms tend to have a low elevation and are subject to saltwater flooding during major storm surges and elevated tides.

One of the characteristic features of barrier islands is their instability. Because the islands are composed of unconsolidated and shifting sands, they tend to migrate along the coast in response to littoral currents as well as a gradually rising sea level. The transient, migratory nature of the barrier island landform is essential to its role as the first line of defense of the mainland. The impact of storm waves and hurricane surges on the shore is greatly reduced by the barrier effect of these landforms. Many harbors and coastal communities along low-lying portions of the Gulf Coast owe their permanence to such protection.

The fact that barrier beaches (spits and islands) enclose estuaries and lagoons, which serve as the nursery ground for numerous marine species, makes these landforms especially important in maintaining the productivity of the coastal zone. Barrier changes, either natural or artificially induced, tend to affect the estuarine system performance.

These closely related systems have evolved together and can withstand the dynamic nature of the oceanic environment, but are very susceptible to human disturbance.

There are three main theories of barrier island genesis: (1) upbuilding of submarine bars (deBeaumont-Johnson theory); (2) spit growth and later segmentation by inlets (Gilbert-Fisher theory); and (3) mainland beach ridge submergence (Hoyt theory). The type of barrier island found in a given geographical region reflects the geological history of that particular region, sediment supply, oceanic forces, and relative sea level changes. Barrier island formation by submarine bar upbuilding has been one of the major theories connected with formation of the majority of these landforms within the Gulf of Mexico region and supported by scientists here. Material from the nearshore bottom is transported landward by waves to form an offshore bar (or shoal) that eventually builds above sea level as an emergent barrier. Inspection of historical aerial photographs, maps and charts by coastal scientists have shown that some small Gulf Coast barrier islands have originated by this means. Hoyt, however, proposed that as sea level rose, dune ridges on the seaward edge of the mainland became the barrier islands. The lower areas behind these ridges were flooded, creating lagoons. This appears to be the major means of barrier formation along the southeast Atlantic and perhaps Gulf Coasts (Leatherman, 1982).

Barrier islands may also form at the mouths of major rivers which deposit large quantities of sediment in the ocean. For instance, small barriers have developed on the Mississippi River delta through wave erosion and reworking of these riverine sediments.

Marshy platforms or cheniers can originate in a low-energy environment, where a large proportion of the sediment in transport is silt, clay, and very fine sand. Ridges are created when storm surges push sandy/shelly sediment landward from the shoreline for deposition on the marsh surface. These strandplains, which are often not true barriers, are best developed along the Louisiana-Mississippi coastline, having derived their sediment from the Mississippi River delta system. Cheniers, which are the lowest of all barrier types and the most vulnerable storm surges are generally strandplains instead of true barrier structures and consist largely of organic deposits (salt marshes) with ridges of sand and silt overlying this basal structure. These marshy plains are often merely seaward extensions of the mainland. Cheniers are best developed along the west Louisiana-east Texas coastline, downdrift of the silt-laden Misssissippi River, which serves as the sediment source. During hurricanes, severe erosion and extensive flooding of the chenier occurs, often forming the characteristic elongated beach ridges.

A barrier beach includes more than just the beach itself; it is a complete system of beaches, dunes, marshes, and flats. Each of these geomorphic elements has a characteristic shape, which results from distinct or a combination of processes. The beach is generally composed of the foreshore, the sloping portion of the beach facing the ocean, and the backshore, that portion of the beach from the berm crest to the dunes. The berm is the region most directly affected by waves during storms and, therefore, is quite unstable. The berm grades into the dune zones, but in some cases the beach foreshore may be adjacent to the dune line so that the berm may not exist. The dune zone of a barrier beach generally consists of a single dune ridge, several parallel dune ridges, or a number of curving lines which are stabilized by beachgrasses. Islands that are subject to periodic or regular overwash tend to be dominated by scattered dunes with extensive barrier flats. The barrier flat is an extensive plain that can support grasslands, shrub-thickets, or woodlands; however, the area is primarily dominated by grassland communities. On the backside of a barrier is the intertidal zone of the lagoonal system or estuarine environment, which is divided into two topographically distinctive parts. This includes the high marsh which is a region of the intertidal zone that ranges from the highest spring tides to the neap tide, and the low marsh, which extends from the high neap tide to mean sea level. This region is flooded by every tidal cycle and is also largely responsible for the organic productivity of salt marshes (Leatherman, 1982).

The following description of the Central and Western Gulf barriers is taken from USDI's "Coastal Barrier Resources System - Draft Report to Congress," April 1985.

Central Gulf of Mexico

Dauphin Island, Alabama, consists of an eastern core against the entrance into Mobile Bay, and a younger, long, low-profile western spit, undoubtedly built by sediment moving westward in longshore transport from the older core. On the eastern core, the island is fronted by dunes up to 30 ft high along most of its seaward shore. The ground elevation within much of the core is well over 10 ft. The historical settlement on Dauphin Island was located on the bay side of this core. This is believed to be the most stable part of the island. The western spit of Dauphin Island, in contrast, was breached and separated from its eastern core by a hurricane in 1916. The breach was initially more than 5 miles wide and began at the immediate western end of the older core. By the early 1940's, the breach had healed. A smaller hurricane breached the island again, within the same area, in 1947, but this time the break healed very quickly. When Dauphin Island was connected to the mainland of Alabama by a causeway in 1955, the scars of the former breaches were only evident to trained observers, and development of vacation homes on the western spit began. Hurricane Frederic, which made landfall on the Alabama coast in 1979, completely devastated this western development and also blew down the causeway. Maximum damage and beach erosion occurred exactly within the developed segment on the western low-profile spit. In spite of historical documentation of repeated damage and good understanding of the physics of a system that focuses storm wave energy on the western spit, some $35 million of National Flood Insurance funds were expended to assist in rebuilding the vacation homes in exactly the same location, and an equivalent amount of public funds were expended to rebuild the causeway.

Most of Mississippi's coastal barriers are part of the Gulf Islands National Seashore and are all relatively young. They are well vegetated by a southern maritime climax forest of pine and palmetto. The islands generally have high beach ridges yet may be overwashed by strong storms. Hurricane Camille, which struck the Mississippi coast in 1969, cut Ship Island into two segments. The breach Camille cut has as of yet shown no sign of healing. The same hurricane produced extensive washover fans on Horn Island. All the barriers are moving towards the west at a rapid rate through erosion of their eastern ends and accretion on the west. In this way, Horn Island has migrated over 1.5 miles westward during the last century. In a natural system, such migration would cause no problems, but dredged channel entrances into various Gulf coast harbors create limits to the tolerance for barrier migration. A minimum of housing structures exist on the Mississippi coastal barriers, which may be why they have the widest and best maintained beaches along the entire Gulf coast. In the absence of housing and stabilization measures, beaches may change their location over time, but will not disappear.

The Mississippi River deltaic plain extends from the Louisiana-Mississippi state line in the east to Marsh Island and Vermilion Bay in the west. About three-fourths of the Louisiana coastline flanks the Mississippi delta. The term Mississippi River delta refers to the entire delta complex, in other words, that part of coastal Louisiana which has been built by the Mississippi River over the last 6,000 years. At present, only the tip of the Mississippi delta in lower Plaquemines Parish, and the Atchafalaya delta at the head of Atchafalaya Bay, are actively building. Other, older "lobes" of the delta complex are being eroded and inundated by locally rising sea level.

The cycle of Mississippi delta lobe evolution is as follows: (1) a delta lobe forms in one location and large quantities of sand are deposited near the river mouth; (2) the main branch of the Mississippi River changes course to a new and shorter route to the sea; (3) waves and longshore currents redistribute the abandoned river mouth sand deposits, building barrier spits and bars; (4) the abandoned delta front rapidly sinks into earlier delta deposits, the sea gradually separates the barrier chain from the adjacent mainland; and (5) the barrier drowns, forming an inner shelf shoal. This evolutionary cycle for Louisiana's barrier islands is probably not that different from the evolution of some other barrier systems along the United States coastline, but because of the more rapid sinking of the delta plain in Louisiana, the barriers change faster than barriers in most other coastal states.

Bayou Lafourche was the main channel of the Mississippi River until some 500-700 years ago. At its maximum size the Lafourche delta extended a few miles seaward of the present shoreline at Fourchon and Grand Isle. Sand from the Lafourche delta (headland) were transported laterally to build the eastern Caminada spit and Grand Isle and the western islands of East Timbalier and Timbalier. This pattern is very similar to that observed in southwest Florida: a central headland erodes into symmetrically distributed spits and barrier islands. The fact that in Louisiana the headland sand source is a delta, whereas in Florida it is not, makes little difference to the resulting barrier pattern. As the Lafourche delta began to sink, the beaches began to retreat.

Louisiana has the most rapidly retreating beaches in the nation. The average retreat rate for the Fourchon beach over the last 100 years has been in excess of 60 ft/yr. The statewide average according to Dolan et al. (1982) is in excess of 12 ft/yr. The consequences of barrier island retreat are observed at Isles Derniers in Terrebonne Parish and at the Chandeleur Islands in St. Bernard Parish. These barrier islands once flanked central headlands like the central headland at Fourchon, but both have subsequently become separated from the mainland. The St. Bernard delta lobe, the older of the two, is about 3,500 years old and the associated islands, the Chandeleur Islands, are farther from the mainland than any other barrier island system in Louisiana, or anywhere else in the nation. Delta lobes older than the St. Bernard do not have associated barrier islands any longer. There are reasons to believe, however, that some of the sandy shoals on the Louisiana continental shelf are older, now drowned, barrier islands.

Most of Louisiana's barrier islands are hardly developable as vacation resorts because of the low aesthetic quality of the Louisiana coastal plain, their inaccessibility, and their extremely high rates of migration. Thorough documentation of their patterns of change, however, is already proving to be of help in developing predictive models for barrier island evolution elsewhere. Even the rates of change observed in Louisiana may be of nationwide applicability if the anticipated acceleration in global sea level rise should become a reality.

The Chenier Plain of the Louisiana coast between Vermilion Bay and the Sabine River is geologically unique along the United States coastline. It owes its origin to the vast quantities of fine-grained (muddy) sediments issued by the Mississippi River and the moderate wave climate of the north-central Gulf of Mexico.

The Chenier Plain is separated from the deltaic plain to the east by Southwest Pass, which is 150 ft deep. Deep tidal passes are not uncommon along the Louisiana coast. Although the tidal range is small, only 1.6 ft at Southwest Pass, the tidal discharge through this pass is very large, both because of the size of Vermilion Bay and the pattern of wind-driven circulation in the bay which causes frequent transport of Atchafalaya Bay water into Vermilion Bay and out through Southwest Pass. The depth of the pass is probably more a reflection of these storm-events than the volume of daily exchange of tidal waters.

Mud from the Mississippi River outlets has always been transported to the west by the prevailing westward flowing coastal currents off Louisiana. For the last 3,000 years the Chenier Plain has been a site of rapid coastal accretion in response to this mud supply. The growth, however, has not been uniform. Periods of rapid accretion of mudflats have alternated with periods of coastal retreat. During phases of retreat, the coarser sediment, primarily shell-hash, has been concentrated and deposited as linear ridges or "cheniers." These ridges attain local elevations above 10 ft and constitute the only high, and relatively dry ground in Cameron and Vermilion Parishes. The land in between the ridges is at or only a few feet above sea level and permanently wet.

The Chenier Plain is fronted by mudflats instead of the usual sandy beaches. Fluid mud, with a consistency like yogurt, extends from the seaward edge of the marsh grasses to a few hundred yards offshore. The mud is an extremely effective wave absorber; the mainland shore is rarely exposed to any wave action except during storms.

Technically, the chenier ridges do constitute barriers protecting the wetlands on their landward side. The danger of inhabiting the chenier ridges is fully comparable to that of living on barrier islands, as was amply demonstrated when Hurricane Audrey flooded most of Cameron Parish in 1957 and killed an estimated 500 people.

Western Gulf of Mexico

The Texas coast is a continuous barrier shoreline. The barrier spits and islands were formed from sediments supplied from three deltaic headlands: the Trinity delta in Jefferson County immediately west of the Sabine River: the Brazos-Colorado Rivers delta complex in Brazoria and Matagorda Counties; and the Rio Grande delta in southernmost Cameron County.

The Texas barriers are arranged symmetrically around these erosional deltaic headlands. Because the shoreline has been straightened by this process, the longshore currents flowing northward have now reversed, and net sediment transport along the entire upper Texas coast today is towards the southwest.

Climate is another important variable that greatly affects Texas coastal barriers. Texas is the only Atlantic or Gulf coastal state with a significant climatic range; the coastal zone is humid subtropical in the east and semiarid in the south. South of Corpus Christi the annual evaporation exceeds the precipitation and the landscape has an arid appearance outside the irrigated valleys. On high-profile, southern barriers, vegetation is sparse, and continuous winds have built high dunes.

The rapidly advancing developments along the Texas barrier coastline are faced with problems similar to many other states, yet the length and variability of coastline offers greater possibilities for planning development scenarios consistent with natural processes. These processes, the rates of shoreline retreat, the high frequency of hurricane landfalls, and the effects of winter storms, are all well-known.

b. Wetlands

Most of the coastal wetlands in the Gulf coastal plain are located in Louisiana, in association with the Mississippi River deltaic plain. This deltaic plain is characterized by cyclical episodes of delta growth, erosion, and environmental change. Wetlands in coastal Louisiana are usually established on a substrate of alluvial sediment that is subject to high, natural subsidence rates (Gagliano et al., 1981). The effects of natural subsidence are compounded by sea level rise, which has been occurring during the past several millennia. Under natural conditions, sedimentation encourages vertical accretion of wetland areas and may offset the submergence and inundation that result from subsidence and sea level rise.

During historic times, the natural deltaic processes and balance of sedimentation and submergence have been interrupted by extensive alterations in the hydrology of the Mississippi River basin and delta. These interruptions are implicated in the extensive wetlands changes that have occurred in this century. These changes include shifts in wetland habitats and conversion of marsh to open water.

The deterioration of coastal wetlands, particularly in Louisiana, is an issue of concern. It has been estimated that Louisiana is losing up to 50 square miles of wetlands every year. MMS is currently funding a study, "OCS Development and Potential Coastal Habitat Alteration," to examine wetlands loss. Additional discussion of wetlands loss is included in Sections IV.D.1.a.(1) and IV.D.2.a.(1) and Appendix E.

The importance of the coastal wetlands to fish and wildlife resources is well-documented. FWS studies indicate that Louisiana contains 40% of the vegetated coastal wetlands in the conterminous United States and 64% of the tidal marshes along the Gulf of Mexico. The Louisiana coastal wetlands support over two-thirds of the Mississippi Flyway wintering waterfowl population (including 20%-25% of North America's puddle duck population) and the largest fur harvest in North America (from 40%-65% of the Nation's total per year) (Olds, 1984).

Approximately 150 active colonial bird nesting sites have been observed in those wetlands and the alligator population presently exceeds 500,000 (Olds, 1984). Approximately three fourths of the estimated 1982 Gulfwide harvest of 2.3 billion pounds of commercial fishes and shellfishes valued at $114 million were landed in Louisiana (Olds, 1984). In 1979, recreational fishermen in Louisiana made 3 million trips in pursuit of marine and estuarine species, expending an estimated $54.5 million in that effort (Olds, 1984).

2. Offshore Habitats

The offshore habitats of the Gulf of Mexico are discussed in Section II.B.2. of the Final Regional EIS (Volume 1), Final EIS 81/84, and Final EIS 94/98/102. Stipulations designed to protect those offshore habitats sensitive to oil and gas activities are discussed in Sections II.A.1.c.(1) and (2) and II.B.1.c.(1). The following discussion is a summary of the information documented in the cited EIS's, updated or expanded as appropriate.

The term "offshore habitats" refers to the water column and the seafloor. These habitats are discussed generally for each of the regions of the Central and Western Gulf, the shelf and the slope and deep sea. Particular emphasis is given to the benthos since those biota are most likely to be affected by oil and gas operations.

Shelf

Generalizations about the biota of the water column are not possible because of the patchy nature of distribution. The biota of the water column are divided into plankton and nekton. Plankton are distributed in patches of various sizes which move with the prevailing winds and currents. Other factors, such as the availability of nutrients and grazing pressure, affect the size and distribution of the patches. In general, planktonic species diversity decreases with decreased salinity, and biomass decreases with distance from shore.

Nekton are represented by five major taxonomic categories -- marine mammals, reptiles, fishes, cephalopod mollusks, and crustaceans. Individuals commonly range over broad areas; however, most nekton are limited to geographical and vertical ranges by the same environmental conditions as less motile organisms, i.e., temperature, salinity, and available food. Most of the fishes are temperate with incursions of Caribbean faunas and exhibit seasonal distribution and abundance fluctuations which are probably largely related to oceanographic conditions.

The benthos has both floral and faunal components; the floral representatives being algae and seagrasses. The abundance of benthic algae is limited by the scarcity of suitable rocky substrates and light penetration. Rezak et al. (1983) recorded algae from submarine banks off Louisiana and Texas. In exceptionally clear waters, benthic algae, especially coralline red algae, are known to grow in water depths up to at least 183 m. Offshore seagrasses are not conspicuous in the Western Gulf; however, fairly extensive beds may be found in estuarine areas behind the barrier islands. Seagrasses would be continuous around the entire periphery of the Gulf if it were not for the adverse effects of turbidity and low salinity of the Mississippi River effluent from the delta to Galveston (Humm, 1973).

Benthic fauna include the infauna (animals which live in the substrate such as burrowing worms and molluscs) and epifauna (animals that live on the substrate such as molluscs, crustaceans, hydroids, sponges, and echinoderms). Shrimp and demersal fish are closely associated with the benthic community. The distribution of benthic fauna correlates with physical factors (Defenbaugh, 1976). Substrate is the single most important factor. Temperature and salinity are also important in determining the extent of faunal distribution. Other lesser important factors include illumination, exposure to air, nutrient availability, currents, tides, and wave shock. Defenbaugh (1976) states that depth and/or distance from shore should also be considered as major influences on the benthic faunal distribution.

Defenbaugh distinguished 12 benthic faunal assemblages in the Gulf oriented generally along isobaths. Generally, seven of these assemblages occur in the Central and Western Gulf and are considered Carolinian Disjunct fauna. At approximately the DeSoto Canyon, a major transition occurs into the Caribbean fauna of the Eastern Gulf.

The demersal shelf fauna fall naturally into four basic classes: nearshore, midshelf, outershelf, and transshelf groups. The demersal fauna exhibit coastal distribution patterns such as regional dominance, aggregation off passes, population insularization off Texas, and seasonal concentration near the Mississippi and Rio Grande River mouths. In the demersal fauna, seasons of peak abundance differ from species to species, with spring having the fewest and fall the most species showing peaks. Seasonality in distributional expansion, high density, rareness or absence, and depth-related shifts in distribution or density also occur (Darnell et al., 1983).

The shelf and shelf edge are characterized by topographic features which are inhabited by benthic communities. The benthic organisms on these features appear to be depth related; however, the actual limiting factors are temperature and light penetration (turbidity and sedimentation). The 18°C and 16°C surface isotherms are determinative of reefal growth. A temperature of 18°C is the minimum seasonal temperature for the vigorous growth of reef-building coral. The 16°C isotherm is stressful for most coral and is considered the lower limit for coral growth (Rezak et al., 1983).

The amount of light reaching the benthic environment is also a limiting factor in coral growth. The light penetration can be affected by increased water depth, turbidity from the rivers entering the Gulf, and by the bottom nepheloid layer. Where any of these circumstances exist, coral growth is inhibited. Therefore, coral growth is limited by depth from the surface and by distance from surrounding substrate and nepheloid layer. Because the coral communities must be close enough to the surface of the water for adequate light penetration and yet removed from the seafloor to escape the effects of the nepheloid layer, the topographic features (or banks) present the proper conditions for coral growth. The type of community on the different banks is further limited by such factors as water temperature and proximity to river discharge (Rezak et al., 1983).

Rezak et al. (1983) identified seven distinct biotic zones on the banks of the Gulf. None of the banks contain all of the seven zones. The zones are divided into four categories dependent upon the degree of reef building activity in each zone as follows:

Zones of Major Reef Building and Primary Production

Diploria-Montastrea-Porites Zone

This zone is characterized by 18 hermatypic coral species. The dominant species of the zone in order of dominance are *Montastrea annularis*, *Diploria strigosa*, *Montastrea cavernosa*, *Colpophyllia* spp., and *Porites asteroides*. The biotic zone was named before the order of dominance was known; therefore, the name does not reflect the true order of dominance. Coralline algae are abundant in the *Diploria-Montastrea-Porites* Zone, adding substantial amounts of calcium carbonate to the substrate. Leafy algae are sparce probably due to grazing. Typical sport and commercial fish which frequent the *Diploria-Montastrea-Porites* Zone include: groupers, hinds, amberjacks, barracuda, red and vermilion snapper, cottonwick, porgys, and creole fish. This high diversity coral reef zone is found only at the East and West Flower Garden Banks.

Madracis Zone and Leafy Algae Zone

The *Madracis* Zone is dominated by the small branching coral *Madracis mirabilis*, which produces large amounts of carbonate sediment. In places, large (possibly ephemeral) populations of leafy algae dominate the *Madracis* gravel substratum (Leafy Algae Zone). The *Madracis* Zone appears to have a successional relationship with the *Diploria-Montastrea-Porites* Zone. *Madracis* remains build up the substrate and allow the successional species to grow.

Stephanocoenia-Millepora Zone

The *Stephanocoenia-Millepora* Zone is inhabited by a low diversity coral assemblage of 12 hermatypic corals. The eight most conspicouous corals in order of dominance are *Stephanocoenia michelinii*, *Millepora* sp., *Montastrea cavernosa*, *Colpophyllia* spp., *Diploria* sp., *Agaricia* spp., *Mussa angulosa*, and *Scolymia* sp. The assemblages associated with the *Stephanocoenia-Millepora* Zone are not well known. Coralline algae are most conspicuous in this zone. Reef fish populations are less diverse. The American thorny oyster (*Spondylus americanus*) appears numerous in the zone. The lower diversity coral reefs are found at the Flower Gardens, McGrail Bank (formerly 18 Fathom Bank), and Bright Bank.

Algal-Sponge Zone

The algal-sponge zone is the largest of the reef-building zones in terms of area. The dominant organisms of the zone are the coralline algae. The coralline algae are the most important carbonate nodule producers. The algae nodules range from 1-10 cm in size and cover 50%-80% of the bottom.

The algae nodules create a habitat which supports communities which are probably as diverse as the coral reef communities. Most of the leafy algae found on the banks occur in this zone. The leafy algae contribute large amounts of food to the surrounding communities. In addition to the coralline algae, calcareous green algae (*Halimeda* and *Udotea*) and several species of hermatypic corals are major contributors to the substrate. Deepwater alcyonarians are abundant in the lower algal-sponge zone. Sponges, especially *Neofibularia nolitangere*, are conspicuous. Echinoderms are abundant and also add to the carbonate substrate. Small gastropods and pelecypods are also abundant. Gastropod shells are known to form the center of some of the algal nodules. Characteristic fish of the algal-sponge zone are yellowtail reeffish, sand tilefish, cherubfish, and orangeback bass.

Partly drowned reefs are a major biotope of the algal-sponge zone. They are defined as those reefal structures covered with living crusts of coralline algae with occasional heads of hermatypic corals. In addition to the organisms typical to the rest of the algal-sponge zone, the partly drowned reefs are also inhabited by large anemones, large comatulid crinoids, basket stars, limited crusts of *Millepora*, and infrequently small colonies of other hermatypic species.

Zone of Minor Reef Building

Millepora-Sponge Zone

The *Millepora*-Sponge Zone occupies depths comparable to the *Diploria-Montastrea-Porites* Zone on the claystone-siltstone substrate of the Texas-Louisiana midshelf banks. One shelf edge carbonate bank, Geyer Bank, also exhibits the zone, however, only on a bedrock prominence. Crusts of the hydrozoan coral, *Millepora*, sponges, and other epifauna occupy the tops of siltstone, claystone, or sandstone outcrops in this zone. Scleractinian coral heads and coralline algae are rare.

Transitional Zone of Minor to Negligible Reef-Building

Antipatharian Zone

This transitional zone is not distinct but blends in with the lower algal-sponge zone. It is characterized by an abundance of antipatharian whips growing with the algal-sponge assemblage. With increased water depth, the assemblages of the zone become less diverse, characterized by antipatharians, comatulid crinoids, few leafy or coralline algae, and limited fish (*Holanthias martinicensis*, *Holanthias bermudensis*, *Bodianus pulchellus*, and *Chromis enchrysurus*).

Zone of No Reef Building

Nepheloid Zone

High turbidity, sedimentation, and resuspension occur in this zone. Rocks or drowned reefs are covered with a thin veneer of sediment. Epifauna are scarce. The most noticeable are comatulid crinoids, octocoral whips and fans, antipatharians, encrusting sponges, and solitary ahermatypic corals. The fish fauna are different and less diverse than the coral reefs or partly drowned reefs. These fish species include red snapper, spanish flag, snowy grouper, bank butterflyfish, scorpionfishes, and roughtongue bass. This zone occurs on all banks.

Figure III-2 depicts the location of the topographic features in the Western and Central Gulf. Table III-4 describes the biotic zones found or expected at each bank and gives the depths of the bank crest and surrounding seafloor.

Slope and Deep Sea

The deep-sea area of the northern Gulf of Mexico is much less known than the shelf. Pequegnat (1983) reported observations based on 264 oceanographic stations between 150-3,850 m in an area including the DeSoto and Alaminos Canyons, the Mississippi Trough and Fan, and the Sigsbee Abyssal Plain. Although it might appear that the deep ecosystem of the Gulf in this area is quite uniform, in truth there are some remarkable biotal differences. In fact, the biotal differences justify referring to the Western Gulf as the "true" Gulf and the Eastern Gulf as a divergence of the Atlantic Ocean via the Caribbean Sea.

The euphotic zone receives sufficient sunlight to generate photosynthesis among phytoplankters and fixed plants. Beneath the euphotic zone, and extending to within a meter or so of the bottom, is a huge mass of water which beyond the shelf is largely devoid of sunlight. This is the aphotic zone where photosynthesis cannot occur and where the processes of food consumption, biological decomposition, and nutrient regeneration take place in the cold and dark waters. The lowermost layer is the bottom itself together with the contiguous water a meter or so in thickness. This is the benthic zone, repository of sediments from above, where nutrient storage and regeneration take place in association with the solid and semi-solid substrate (Pequegnat, 1983).

The slope is a transitional environment influenced by processes on the shelf and the abyssal Gulf. This transition applies more to the pelagic than to the benthic realm. The general conclusions which may be reached are as follows: (a) the shelf phyto- and zooplankton are more abundant, more productive, and seasonally more variable than the open Gulf plankton; (b) in these respects, the slope plankton are intermediate but closer to the condition of the open Gulf; and (c) each of the three regions is characterized by some species which are more or less specific to the particular zones. Some east-west differences have been noted, especially among the diatom species. These have also been interpreted as representing the differences between normal Gulf waters and those influenced by Mississippi River water (Pequegnat, 1983).

The production of particulate organic carbons by plankton in the Gulf appears to average about 55 g C/m^2/yr. The highest values are found in the upwelling area north of the Yucatan Channel and in the region around DeSoto Canyon. In the oceanic region the Western Gulf is more productive than the Eastern Gulf. It is generally assumed that perhaps except for brief periods during major plankton blooms, the zooplankton consume all the phytoplankton produced. In turn they excrete a high percentage of their food intake as nutrient-rich feces that sink to the bottom. Most of the herbivorous zooplankters are copepods with calanoids leading all others (Pequegnat, 1983).

Most of the benthic fauna of the deep slope and abyssal plain are not found elsewhere. The 250 m isobath defines the truly deep sea fauna. The deep water benthic fauna have been characterized into seven faunal assemblages by Pequegnat (1983):

The Shelf/Slope Transition Zone (150-450 m) is a very productive part of the benthic environment. Demersal fish are the dominant species, many of them reaching their maximum populations in the zone. Asteroids, gastropods, and polychaetes are common.

The Archibenthal Zone - Horizon A Assemblage is located between 475-750 m. Although less abundant, the demersal fish are a major constitutent of the fauna, as are gastropods and polychaetes. Sea cucumbers are more numerous. Horizon B at 775-950 m represents a major change in the number of species of demersal fish, asteroids, and echinoids which reach maximum populations here. Gastropods and polychaetes are still numerous.

The Upper Albyssal Zone is located between 975-2,250 m. Although the number of species of demersal fish drops, the number which reaches maximum populations dramatically increases. This indicates a group uniquely adapted to the environment. Sea cucumbers exhibit a major increase, and gastropods and sponges reach their highest species numbers here.

At the onset of the Mesoabyssal Zone - Horizon C (2,275-2,700 m) a sharp faunal break occurs. The number of species reaching maximum populations in the zone drops dramatically for all taxonomic groups. The Mesoabyssal Zone - Horizon D Assemblage, located at 2,725-3,200 m depth, coincides with the lower part of the steep continental slope in the Western Gulf. Since the Central Gulf is dominated at these depths by the Mississippi Trough and Mississippi Fan, the separation of Horizon C and D assemblages is not as distinct in the Central Gulf. The assemblages differ in species constitution.

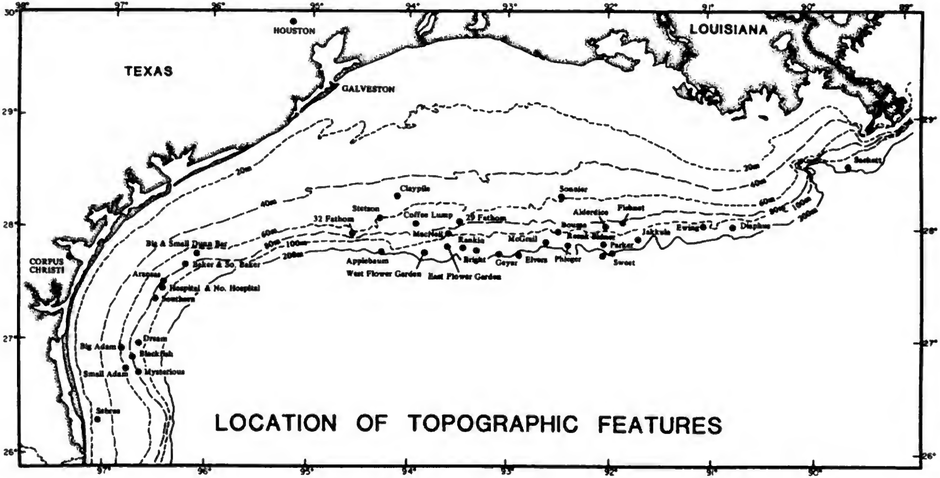

LOCATION OF TOPOGRAPHIC FEATURES

Figure III-2

Table III-4

Biotic Zones of Topographic Features
with Bank Crest and Seafloor Depth in Meters

	Millepora-Sponge	*Diplora*-*Montastrea*-*Porites*	*Madracis*	*Stephanocoenia*	Algal-Sponge	Antipatharian-Transitional	Nepheloid	Seafloor
SHELF EDGE BANKS								
East Flower Garden		15	X	X	X	X	X	100-120
West Flower Garden		20	X	X	X	X	X	110-130
Bright				37	X	X	X	110
McGrail				45	X	X	X	110-130
Geyer	37				X	X	X	190-210
Rankin					52	X	X	110-140
Alderdice					55	X	X	84-90
Rezak					60	X	X	120
Sidner					55	X	X	150
Ewing					56	X	X	85-100
Jakkula					59	X	X	120-140
Bouma					60	X	X	90-100
Elvers					60	X	X	180
Parker					60	X	X	100
MacNeil					62	X	X	86-94
Sackett					67	X	X	100
Diaphus						73	X	110-130
Sweet					75	X	X	130-200
Applebaum					76	X	X	100-120
Phleger							122	200
LOW RELIEF MIDSHELF BANKS								
Claypile	40						X	50
32 Fathom						52	X	55
Coffee Lump						62	X	70
MIDSHELF BANKS								
Sonnier	18						X	50
Stetson	20						X	60
29 Fathom						52	X	72
Fishnet						66	X	78
LOW RELIEF SOUTH TEXAS BANKS								
Sebree							31	37
Big Dunn Bar						61	X	67
Small Dunn Bar						63	X	67
Big Adam						60	X	64
Small Adam						60	X	66
Blackfish						60	X	70-74
Mysterious						70	X	74-86
SOUTH TEXAS BANKS								
Baker						56	X	70-74
Aransas						57	X	70-72
Southern						58	X	80
North Hospital						58	X	68-70
Hospital						59	X	70-78
South Baker						59	X	80-84
Dream						62	X	80

Sources: Rezak and Bright, 1981 and Rezak et al., 1983.

The Lower Abyssal Zone is the deepest of the assemblages at 3,225-3,850 m. Megafauna is depauperate. The zone contains an assemblage of benthic species not found elsewhere.

Chemosynthetic clams and tube worms have recently been discovered in the deep waters of the Gulf. These cold water communities are apparently associated with seismic wipe-out and hydrocarbon seep areas between water depths of 400 and 1,000 m (Kennicutt and Gallaway, 1985). Hydrothermal vent communities of chemosynthetic organisms have been studied in the Pacific (Ballard, 1984). In 1983, an analogous community was discovered at the Florida Escarpment but at ambient temperatures (Florida Escarpment Cruise Participants, 1984). In late 1984, additional chemosynthetic communities were discovered in the Central Gulf at ambient temperatures. Representatives from the genus *Calyptogena*, probably *C. ponderosa*, were identified from the Gulf seep communities. The species is related to the giant clams, *C. magnifica*, found at the Pacific vent sites. In the Pacific, the giant chemosynthetic tube worm, *Riftia pachytila*, also comprises the vent community. However, in the cold water Gulf seeps, closely related chemosynthetic worms are from the family Lamellibrachiidae and a new undescribed family. The hot and cold seeps communities are both characterized by white bacterial mats, large dense beds of clams and mussels, numerous small gastropods and galatheid crabs. The extent of those organisms in the Central and Western Gulf is unknown (Kennicutt and Gallaway, 1985). Studies are ongoing in the Central and Western Gulf to determine the correlation of the seep communities with seismic wipe-out zones and to identify the organisms composing the community. Based on the preliminary findings of these studies, chemosynthetic communities appear to be widespread in areas of hydrocarbon or H_2S seepage in the Central and Western Gulf.

Central Gulf of Mexico

Of the topographic features listed in Table III-4, 16 are located in the Central Gulf:

Shelf Edge Banks	Midshelf Banks
Bright Bank	Sonnier Bank
McGrail Bank	29 Fathom Bank
Rankin Bank	Fishnet Bank
Alderdice Bank	
Rezak Bank	
Sidner Bank	
Ewing Bank	
Jakkula Bank	
Bouma Bank	
Parker Bank	
Sackett Bank	
Diaphus Bank	
Sweet Bank	

(Rankin and 29 Fathom Banks are located along the dividing line between the Central and Western Gulf and, therefore, are considered on both.)

As seen in Table III-4, the shelf edge banks generally exhibit the zonation exhibited at the Flower Garden Banks at comparable depths. Diaphus Bank which crests at 73 m might be expected to contain the algal-sponge zone since the crest is sufficiently removed from the seafloor to escape the affects of the nepheloid layer. However, because of the bank's proximity to the Mississippi River discharge, the algal-sponge zone is not found. Sackett Bank which crests shallower than Diaphus is also affected by the Mississippi River. Although Sackett Bank is characterized as having an algal-sponge zone, this zone is weakly represented and environmentally stressed (Rezak et al., 1983). Phleger Bank is located in deep waters and crests deeply. Although the crest is in clear water, the biota is typical of the nepheloid zone because of the depth (Rezak et al., 1983).

Three of the Central Gulf banks are classified as midshelf banks, Sonnier, 29 Fathom, and Fishnet Banks. Because of their midshelf location resulting in lowered light penetration and temperature minimum, the biotic zones do not correspond to the same zones at similar depths on the Flower Gardens. Instead of the high diversity coral reef zone found at the Flower Gardens, the midshelf banks at similar depths exhibit the lower diversity *Millepora*-sponge zone. This zone is evident at Sonnier Bank in the Central Gulf.

The northeastern portion of the Central Gulf exhibits a band of pinnacles, the "pinnacle trend," between 220-360 ft depth. The pinnacles appear to be dead reefal structures (Ludwick and Walton, 1957). These pinnacles exist in turbid water and contain limited biotal coverage. Pinnacles were photographed in 1985 by Continental Shelf Associates (CSA). CSA described the biota on the pinnacles as similar to the transitional antipatharian zone assemblage described by Rezak (CSA, 1985). These pinnacles may provide structural habitat for a variety of pelagic fish. The MMS through the studies program, is further studying the extent and importance of the pinnacle area.

The substrate in waters shallower than 220 ft is a mixture of mud and/or sand (Vittor and Associates, 1985). The live bottom surveys required by MMS and conducted in the area reveal sand or mud substrate. These areas are not conducive to "live bottom" community growth since a hard substrate is needed for epifaunal attachment. As the substrate grades to carbonate sand in the Eastern Gulf, the potential for "live bottoms" increases.

Western Gulf of Mexico

Of the topographic features listed in Table III-4, 27 are located in the Western Gulf:

Shelf Edge Banks

East Flower Garden Bank
West Flower Garden Bank
Geyer Bank
Rankin Bank
Elvers Bank
MacNeil Bank
Applebaum Bank
Phleger Bank

Midshelf Bank

Claypile Lump
32 Fathom Bank
Coffed Lump
Stetson Bank
29 Fathom Bank

South Texas Banks

Sebree Bank
Big Dunn Bar
Small Dunn Bar
Big Adam Bank
Small Adam Bank
Blackfish Ridge
Mysterious Banks
Baker Bank
Aransas Bank
Southern Bank
North Hospital Bank
Hospital Bank
South Baker Bank
Dream Bank

(Rankin and 29 Fathom Banks are located along the dividing line between the Central and Western Gulf and, therefore, are considered in both.)

As seen in Table III-4, the shelf edge banks generally exhibit the zonation exhibited at the Flower Garden Banks at comparable depths. Of interest is Geyer Bank which crests at 37 m, within the depth that the high diversity coral reef zone is expected. However, at this bank, the *Millepora*-sponge zone is evident. The *Millepora*-sponge zone is found elsewhere in the Gulf only at the midshelf banks.

Three of the midshelf banks contain the *Millepora*-sponge zone: Sonnier Bank in the Central Gulf and Stetson and Claypile Banks in the Western Gulf. Claypile Bank, often with only 10 m of relief, is considered a low relief bank and is often enveloped by the nepheloid layer. Thus, the level of development of the *Millepora*-sponge community is lowest at Claypile Bank. Two other midshelf banks on the Western Gulf have relief less than 10 m and are considered low relief, 32 Fathom Bank and Coffee Lump.

The south Texas banks are geographically/geologically distinct from the shelf edge banks. Several of the South Texas Banks are also classified as low relief banks (Table III-4). North Hospital Bank has not been classified here as a low relief bank even though its relief is within the arbitrary 10 m which designates the other low relief banks. North Hospital and Hospital Banks are in such proximity that North Hospital is included with the higher relief Hospital Bank.

Sebree Bank is a low profile feature located in 120 ft of water. The highest area of the bank is about 102 ft deep. The bank appears composed of large boulders mostly veneered by fine sediments. The low relief of the bank and the fines covering the bank indicate that Sebree Bank frequently exists in turbid conditions. The biota of the bank appears sparse due to these conditions. Specimens of *Oculina diffusa* have been collected. The bank attracts abundant nektonic species including red snapper (Tunnell, 1981).

The topographic and physical oceanographic conditions present at the East Breaks in the Western Gulf are such that a nutrient rich upwelling could be expected in the vicinity. NMFS has reported that the area is an important recreational billfishing area. The upwelling may contribute to this fishery.

3. Endangered and Threatened Species

Five Federally listed endangered whale species occur in the Gulf of Mexico. These include the fin, humpback, right, sei, and sperm whales. Usually, these large cetaceans inhabit the continental slope and deep oceanic waters; occasionally, they are sighted nearshore (Schmidly, 1981). Sperm whales have been sighted offshore Brownsville, Texas (Fritts et al., 1983).

Endangered red wolf hybrids occur along the Gulf coast in Cameron Parish, Louisiana and Jefferson County, Texas; pure-blood red wolves are extinct in the wild (McCarley and Carley, 1979).

The endangered Alabama beach mouse, Perdido Key beach mouse, and the Chotawatchee beach mouse occur along the eastern Alabama and northwestern Florida Gulf beaches (50 FR 109, June 6, 1985).

Federally listed endangered sea turtles (Kemp's ridley, green, hawksbill, and leatherback turtles, and the threatened loggerhead turtle) occur in the Gulf of Mexico. The green turtle is listed as endangered in Florida waters and threatened throughout the rest of the Gulf of Mexico. The Kemp's ridley turtle inhabits shallow coastal and estuarine waters. Ridley turtles commonly occur in shallow water areas from Marsh Island to the Mississippi Delta in Louisiana (Hildebrand, 1982) and from Bolivar Roads to Sabine Pass in Texas. Kemp's ridley turtles infrequently nest on the beaches of southwestern Padre Island, Texas, where FWS, NMFS, and NPS have established a ridley turtle head start release program. The green turtle is found throughout the Gulf where its favored habitats are lagoons and shoals providing an abundance of marine grass and algae on which it feeds. No recent green turtle nesting has been reported along Gulf beaches. Juvenile green turtles occur in Texas estuaries (Hildebrand, 1982) and along the southwest Florida coast. The hawksbill turtle inhabits reefs, shallow coastal areas, and passes in water less than 20 m deep. Hawksbill nesting has been reported along the Gulf coast of Florida. The leatherback turtle is the most pelagic marine turtle and may be found near the continental shelf edge. Sightings have been reported along the Gulf coast in March and April; no recent nesting has been reported along the Gulf coast. The loggerhead turtle occurs throughout the Gulf and has been observed as far as 500 miles out in the open sea. They nest on barrier islands and beaches from the Florida Keys, up the southwest Florida coast where the majority of nesting in the Gulf occurs (Harris et al., 1984), and west to Padre Island off Texas where infrequent nesting occurs. Visual No. 3 (Final EIS 94/98/102) indicates the general locations of marine turtle nesting.

The American alligator occurs generally throughout the Gulf coast region in fresh to brackish water areas. The alligator is listed as endangered throughout its range except in the coastal areas of Texas where it is listed as threatened and in Florida and Louisiana where it is listed as "threatened by similarity of appearance."

The endangered red-cockaded woodpecker occurs primarily in mature open pine forests throughout the Eastern and Central Gulf area and into eastern Texas.

Endangered Arctic peregrine falcons migrate along the Gulf coast, and some peregrine falcons overwinter in Gulf coastal areas.

Brown pelicans have been removed from the Federal endangered species list in Alabama and Florida but remain listed as endangered in Mississippi, Louisiana, and Texas. A small population of brown pelicans nest on Gaillard Island in Mobile Bay near Theodore, Alabama. Three small brown pelican rookeries (about 2,500 birds) occur at North Island, northern St. Bernard Parish, and Queen Bess Island in Louisiana. Also, a small population (about 500 birds) of brown pelicans occur near Corpus Christi, Texas, and a small number of brown pelicans from Mexico feed along the southwestern coast of Texas. The habitat of these colonial nesters are small coastal inlands in salt and brackish water areas as indicated on Visual No. 3 (Final EIS 94/98/102).

Endangered bald eagles inhabit several Gulf coastal counties; the majority of this population occurs in Florida. A small population of endangered Mississippi sandhill cranes inhabits an area in Jackson County, Mississippi. Small discrete populations of endangered Attwater's prairie chicken occur in the coastal prairie of the mid Texas coast. A small population (about 80-90) of endangered whooping cranes overwinters at the Aransas National Wildlife Refuge near Aransas, Texas, and surrounding wetland areas from October through April.

Additional information on endangered and threatened species is found in the FWS and NMFS biological opinions in Appendix C and on Visual No. 3 (Final EIS 94/98/102).

4. Other Wildlife Species

Other wildlife species which could be impacted by OCS oil and gas activities are discussed below and includes marine mammals and coastal and marine birds. FWS has produced a "Gulf Coast Ecological Inventory" and a set of 22 (1:250,000 scale) maps which are excellent sources of information pertaining to wildlife species along the Gulf coast (Beccasio et al., 1982).

a. Marine Mammals

About 28 species of marine mammals (Table III-5) have been reported to occur in or migrate through the Gulf region (Schmidly, 1981). Those which occur in coastal waters are primarily the West Indian manatee, small cetaceans (porpoises and dolphins), and occasionally large cetaceans (whales). The whales were discussed in Section III.B.3.

The bottlenose dolphin is the most common small cetacean which occurs in bays, inland waterways, ship channels, and nearshore waters in the northern Gulf of Mexico. Surveys of the Louisiana-Mississippi coastal waters reported about 2,000-6,000 bottlenose dolphins (Leatherwood and Platter, 1975). Aerial surveys offshore Marsh Island, Louisiana, indicate about 1 dolphin/1.4 mi^2 (1 dolphin/3.7 km^2) (Fritts et al., 1983). Surveys offshore Texas reported about 1,000-5,000 dolphins (Orr, 1977). Aerial surveys indicate about 1 dolphin/1.9 mi^2 (0.203 dolphins/4.9 km^2) offshore Brownsville, Texas (Fritts et al., 1983). Dolphins usually occur in herds of 3-7 animals, but large herds of 200-600 dolphins have been observed. Spotted, striped, and spinner dolphins are other small cetaceans which occur in the Gulf continental shelf waters. Short-finned pilot and pygmy sperm whales occur in the deeper Gulf slope and oceanic waters.

b. Coastal and Marine Birds

The beaches and coastal wetlands of the northern Gulf of Mexico region are inhabited by several migrant and nonmigrant coastal bird species, consisting primarily of three general groups: shorebirds, wading birds, and waterfowl. Feeding and nesting areas include beaches, coastal bays, and other coastal wetland areas. Reproductive activity for these groups occurs from February through August (Portnoy, 1977 and Clapp et al., 1982). Portnoy (1977) recorded 847,000 birds of 26 species in habitats ranging from swamp forest to coastal marshes and barrier islands in the Central Gulf area; the most abundant species were the Louisiana heron, snowy egret, and cattle egret.

The northern Gulf of Mexico coastal wetlands are the overwintering site for about 4-7 million migratory waterfowl (Bellrose, 1976). The peak of the fall migration is November-December and spring migration occurs from March to early May. The major waterfowl habitats are coastal bays and wetland areas. The national wildlife refuges and State wildlife management areas provide important feeding, nesting, and resting areas for many of these migratory waterfowl. Recreational hunting of waterfowl along the Gulf coast is an important source of recreation and income. During the 1977-1978 waterfowl season 676,000 hunter-days were recorded for the Louisiana coastal areas.

Marine birds, such as gulls, terns, boobies, petrels, and shearwaters, occur in the Gulf continental shelf region (Murphy, 1967 and Clapp et al., 1982). Marine birds primarily feed and roost offshore, coming ashore for nesting or when storms blow them inshore. Generally, the largest concentrations of marine birds are found near upwelling areas (near the continental slope edge) and other areas of high productivity. Aerial surveys offshore Marsh Island, Louisiana, found 25 species of marine birds and 96% of all marine birds sighted were gull and tern species; surveys offshore Brownsville, Texas, found 24 species of marine birds and 91% of all marine birds sighted were gull and tern species (Fritts et al., 1983).

5. Commercial Fisheries

Nearly all species significantly contributing to the Gulf's commercial catches are estuarine dependent. With the exception of such species as the oyster and spotted seatrout, most leave the estuaries as juveniles or subadults and spawn at sea after becoming reproductive adults. The eggs of the majority of these species hatch in the waters of the

Table III-5

Marine Mammals of the Northern Gulf of Mexico

		Eastern Gulf of Mexico	Central Gulf of Mexico	Western Gulf of Mexico
1	Right whale (*Eubalaena glacialis*)	R*	N	R
2	Blue whale (*Balaenoptera musculus*)	N	N	R
3	Sei whale (*Balaenoptera borealis*)	N	R	N
4	Fin whale (*Balaenoptera physalus*)	U	U	R
5	Bryde's whale (*Balaenoptera edeni*)	R	R	N
6	Minke whale (*Balaenoptera acutorostrata*)	U	R	N
7	Humpback whale (*Megaptera novaeangliae*)	U	N	N
8	Sperm whale (*Physeter catodon*)	C	C	C
9	Pygmy sperm whale (*Kogia breviceps*)	C	R	C
10	Dwarf sperm whale (*Kogia simus*)	R	R	U
11	Blainville's beaked whale (*Mesoplodon densirostris*)	N	R	N
12	Antillean beaked whale (*Mesoplodon europaeus*)	R	N	R
13	Goosebeaked whale (*Ziphius cavirostris*)	U	R	R
14	Pygmy killer whale (*Feresa attenuata*)	R	N	R
15	False killer whale (*Pseudorca crassidens*)	U	R	R
16	Killer whale (*Orcinus orca*)	U	N	R
17	Short-finned pilot whale (*Globicephala macroryhnchus*)	C	U	C
18	Rough-toothed dolphin (*Steno bredanensis*)	R	R	R
19	Saddleback dolphin (*Delphinus delphis*)	U	R	R
20	Atlantic bottlenose dolphin (*Tursiops truncatus*)	C	C	C
21	Grampus (*Grampus griseus*)	R	N	N
22	Bridled dolphin (*Stenella frontalis*)	R	N	R
23	Atlantic spotted dolphin (*Stenella plagiodon*)	C	C	C
24	Striped dolphin (*Stenella coeruleoalba*)	C	R	R
25	Spinner dolphin (*Stenella longirostris*)	U	N	U
26	Short-snouted spinner dolphin (*Stenella clymene*)	R	N	R
27	California sea lion (*Zalophus californianus*)	R	R	N
28	West Indian manatee (*Trichechus manatus*)	C	R	N

*N - No strandings or sightings.
R - Rare, 1-3 strandings or sightings.
U - Uncommon, 4-6 strandings or sightings.
C - Common, 7 or more strandings or sightings.

Source: Schmidly, 1981.

open Gulf, and the developing larvae become part of the offshore planktonic community. Under the influence of tides, currents, and winds, the young eventually arrive at the estuarine nursery grounds where they feed, grow, and mature prior to migrating out to sea to repeat the spawning process.

Characteristic fishes are associated with the various Gulf environments. The low salinity estuaries are generally dominated by finfishes such as croakers, spot, sand trout, anchovies, mullet and menhaden, and shellfishes such as oysters and crabs. The shallow Gulf (surf zone) characteristically contains such fishes as the Gulf whiting and Atlantic threadfin. The bottom becomes more muddy outside the surf zone, and fishes found there include the croaker, spot, star drum, silver trout, and longspine porgy. Farther offshore toward the middle shelf, the number of sciaenids (croaker family) is drastically reduced, and the fish community is dominated by small flounders and searobins. The offshore reefs support such fishes as snappers and seabasses, while oceanic fishes such as the bluefin tuna and broadbill swordfish inhabit the offshore open ocean waters (USDC, NMFS, 1979).

In the Gulf of Mexico, the shrimp fishery is the most economically important. Nine species of penaeids contribute to the Gulf's shrimp fishery. Brown, white, and pink shrimp are the three most important commercial species. Brown shrimp are centered in the northwestern Gulf while white shrimp are centered on the mud and sand bottoms off the coast of Louisiana. Pink shrimp have an almost continuous distribution throughout the Gulf, but consistent commercial pink shrimp catches are made on the shell, coral sand, and coral silt bottoms off southern Florida. The Gulf menhaden fishing constitutes the largest fishery in terms of pounds landed. In the Gulf of Mexico, Gulf menhaden occur in the shallow waters of the northcentral Gulf from eastern Florida to eastern Texas with about 93% of this fishing effort occurring within 10 miles of shore.

The industrial bottomfish trawl fishery exists in the nearshore waters of the northcentral Gulf. Generally, the following fishes contribute 95%-98% of the trawl fishery catch: croaker, spot, sand seatrout, silver seatrout, silvereel, catfish, and longspine porgy. Croaker, the largest component of the catch, prefer a mud bottom and are generally not found in depths exceeding 60 fathoms.

Approximately 50 species of food finfish are harvested in the Gulf. Some of the more important include croaker, snappers, groupers, white mullet, red and black drum, spotted and silver seatrout, Spanish mackerel, spot, pompano, flounders, crevalle, Gulf kingfish, sheepshead, and king mackerel. The majority of food finfish are caught in coastal waters with the exception of such fishes as the snappers, groupers, mackerels, tunas, and billfish.

Central Gulf of Mexico

Alabama's dominant commercial catches are the shellfish (shrimp, crab, and oysters), while commercially important finfish include sea trout, spot, Altantic croaker, striped mullet, and southern flounder. Mississippi produces large quantities of shellfish and finfish with shrimp representing the most important catch. Oysters and blue crabs also contribute significantly to Mississippi's shellfish landings. The Gulf menhaden is the principal species of economic value in Mississippi finfish catches, while commercial landings of foodfishes include croaker, snapper, and flounder. In Louisiana, shrimp (primarily brown and white) constitute the most economically important fishery, while menhaden are the basis of the state's largest fishery. Oyster and blue crab fisheries are the state's third and fourth most valuable fisheries, respectively. Other finfishes which contribute significantly to Louisiana's landings include drum, mullet, sea trout, mackerel, and snapper.

Western Gulf of Mexico

Shrimp, oysters, blue crabs, and finfish constitute the principal fisheries in Texas, with shrimp being by far the most important; economically important finfishes include red drum, spotted seatrout, black drum, menhaden, flounder, and striped mullet. In recent years shrimp has consistently accounted for about 75% of landings and 95% of the landings value (Restrepo and Associates, 1982). Bryan (1981) reports that about 80% of the oyster production in Texas comes from the Galveston Bay system. For a more detailed description of commercial fisheries in the Gulf of Mexico, see Volume 1, Section III.B.5. of the Final Regional EIS and Visual No. 4-I.

C. SOCIOECONOMIC CONDITIONS

The socioeconomic impact area comprises 49 counties and parishes. The coastal counties/parishes extend from Baldwin County in Alabama to Cameron County in southernmost Texas. Inland counties/parishes are included where offshore oil and gas support activities are known to exist (such as Lafayette, Louisiana); where offshore-related petroleum industries are established (such as the Mississippi River region in Louisiana); and to account for all counties within Standard Metropolitan Statistical Areas (SMSA) boundaries when one county is on the coast. The counties/parishes in this socioeconomic impact area are:

Central Gulf of Mexico
Alabama - Baldwin, Mobile
Mississippi - Hancock, Harrison, Jackson, Stone
Louisiana - Ascension, Calcasieu, Cameron, East Baton Rouge, Iberia, Jefferson, Lafayette, Lafourche, Livingston, Orleans, Plaquemines, St. Bernard, St. Charles, St. James, St. John the Baptist, St. Mary, St. Tammany, Terrebonne, Vermilion, West Baton Rouge

Western Gulf of Mexico
Texas - Aransas, Brazoria, Calhoun, Cameron, Chambers, Fort Bend, Galveston, Hardin, Harris, Jackson, Jefferson, Kenedy, Kleberg, Liberty, Matagorda, Montgomery, Nueces, Orange, Refugio, San Patricio, Victoria, Waller, Willacy

The Gulf region varies substantially in socioeconomic patterns ranging from low-density, undeveloped rural areas to high-density, highly developed urban centers. There are 12 SMSA's in the region (in east to west order):

Central Gulf of Mexico
Alabama - Mobile
Mississippi - Pascagoula, Biloxi-Gulfport
Louisiana - New Orleans, Baton Rouge, Lafayette, Lake Charles

Western Gulf of Mexico
Texas - Beaumont-Port Arthur, Houston-Galveston-Brazoria, Victoria, Corpus Christi, Brownsville-Harlingen

The most populated SMSA's across the two zones in the region are New Orleans and Houston. The least populated are Pascagoula and Victoria.

The highest levels of employment by major industry group in each state's coastal region are in the areas of manufacturing, wholesale/retail trade, and services (including finance, insurance, and real estate (F.I.R.E.)). A summary of specific employment, income, and population characteristics is given below.

1. Employment

Table III-6 reflects the historic indicators for the labor force and unemployment in the Gulf region. In 1970, the regional unemployment rate (4.0%) was just below that of the United States (4.4%); in 1980, the regional rate (5.6%) was well below the comparable United States figure (7.1%); in 1985, the regional rate (9.6%) was well above that of the United States (7.4%).

Central Gulf of Mexico

Labor force data for the three central states is given in Table III-6. In both 1970 and 1980, all three states' coastal areas had unemployment rates above the regional average. In 1970, the Louisiana and Alabama coastal regions unemployment rates were above the United States rate; while in 1980, the Mississippi and Alabama regions were above the United States rate. In 1985, the unemployment rate for Alabama (9.6%) was equivalent to that of the Gulf region (9.6%) but above that of the United States (7.4%). The unemployment rates for Mississippi (11.1%) and Louisiana (11.2%) were above both the rates for the Gulf region (9.6%) and the United States (7.4%).

The changes in labor force over the 1980-1985 period represents an average annual growth rate of 2.8% for Louisiana, 2.0% for Mississippi, and 4.0% for Alabama.

Employment by major industry group for Alabama is shown in Table III-7. In 1983, the highest levels were recorded in the sectors of trade, services, and manufacturing in order of magnitude for the coastal region. Mobile County accounts for over 85% of all employment in the Mobile SMSA. Between 1970 and 1983, wholesale and retail trade has continued to increase in relative share of the labor force.

Table III-7 also provides employment by major industry group in the Mississippi coastal region. In order of magnitude, the leading sectors in 1983 were manufacturing, trade, and services. Manufacturing was centered primarily in Jackson County (Pascagoula SMSA), while trade and services were concentrated in Harrison County (Biloxi-Gulfport SMSA).

Employment by major industry group for the Louisiana coastal region is also shown in Table III-7. Leading sectors, in order of magnitude, were services, trade, and manufacturing. Manufacturing was far lower in relative share of the labor market in Louisiana than any other state in the Gulf region. Employment in the leading sectors was concentrated in Orleans and Jefferson Parishes of the New Orleans SMSA, and East Baton Rouge of the East Baton Rouge SMSA.

Western Gulf of Mexico

Labor force data for the Texas coastal area is shown in Table III-6. In both 1970 and 1980, the unemployment rate for this coastal zone was below that of the aggregate Gulf region and United States rates. In 1985, the Texas unemployment rate (8.6%) was below that of the Gulf region (9.6%) but above that of the United States (7.4%). The change in labor force over the 1980-1985 period represents a 3.8% average annual growth rate.

Table III-8 gives the breakdown of employment by major industry groups. Leading sectors, in order of magnitude, were services, trade, and manufacturing. In 1983, this employment was highly concentrated in Harris County (Houston-Galveston-Brazoria SMSA) and in Jefferson and Nueces Counties (Beaumont-Port Arthur and Corpus Christi SMSA's, respectively).

2. Income

Total and per capita personal income for the Gulf region are shown in Table III-9. The per capita personal income for the region ($3,500) was 90% of the United States level ($3,900) in 1970. In 1978, the Gulf region and United States figures were equal ($7,900). In 1983, per capita personal income for the Gulf region ($11,900) was slightly above the United States level ($11,700).

Central Gulf of Mexico

Alabama and Mississippi historically have poor personal income indicators. In 1970, the per capita income of these states was 85% and 95% ($3,000 and $3,200) of the Gulf region value ($3,500) and 85% and 90% of the national level ($3,900), respectively. In 1978, Alabama's per capita income had risen above that of Mississippi's, yet both states had dropped to 80% and 77% ($6,300 and $6,100) of both the Gulf region ($7,900) and United States per capita income levels ($7,900), respectively. The per capita income of Alabama in 1983 was 77% ($9,200) of the Gulf region ($11,900) and 79% of the United States figure ($11,700); while the per capita income of Mississippi in 1983 ($8,800) was 74% of the Gulf region and 75% of the United States figure. In 1970, the per capita personal income of Louisiana ($3,300) was 94% of that for the Gulf region ($3,500) and 84% of that for the United States ($3,900). In 1978, the per capita personal income for Louisiana ($11,400) was 94% of that for both the Gulf region and the United States. In 1983, the figure for Louisiana ($11,400) was 95% of the region's figure and 97% of that for the United States.

Average payroll per employee in 1983 was $14,200 for Mississippi, $15,100 for Alabama, and $17,000 for Louisiana.

Western Gulf of Mexico

Texas' Gulf region achieved the largest per capita personal income in the coastal region. In 1983, the Texas coastal zone per capita income level ($12,600) was approximately 6% above that of the Gulf region. In 1970, 1978, and 1983, the Texas coastal region equalled or surpassed the United States per capita income level. Average payroll per employee was $19,900 for the Texas coastal zone in 1983.

Table III-6

Labor Force Data
Gulf of Mexico Region*

	Labor Force (thousands)			Unemployment Rate		
	1970	1980	1985**	1970	1980	1985**
Alabama	133.8	183.1	201.0	5.3%	7.5%	9.6%
Mississippi	78.9	108.1	129.6	4.3%	7.7%	11.1%
Louisiana	742.6	1,081.3	1,231.7	4.9%	5.9%	11.2%
Texas	1,235.3	2,032.7	2,419.3	3.5%	5.0%	8.7%
Gulf Region	2,190.6	3,405.2	3,981.7	4.0%	5.6%	9.6%
United States	82,700.0	106,821.0	115,183.0	4.4%	7.1%	7.4%

*Data shown for each state are for those counties/parishes in the socioeconomic impact area.
**Figures for 1985 are averages of monthly data reported for the January through October period.

Sources: Alabama Dept. of Industrial Relations, Research, and Statistics, 1985.
Labor Force Estimates for Texas Counties, 1980 and 1985.
Labor Market Information, 1980 and 1985.
Labor Market Trends, 1980 and 1985.
USDC, Bureau of the Census, 1985.
USDC, Bureau of Economic Analysis, 1983 and 1985.
U.S. Dept. of Labor, Bureau of Labor Statistics, 1985.

Table III-7

Employment by Major Industry Group*
Central Gulf of Mexico - 1983 Percent of Total

	Alabama		Mississippi		Louisiana	
	Coastal Area	State	Coastal Area	State	Coastal Area	State
Agriculture, Forestry, Fishing	0.6	0.4	0.3	0.5	0.3	0.3
Mining**	0.6	1.2	0.8	1.3	7.5	7.0
Contract Construction	8.3	5.9	3.9	5.8	8.5	8.4
Manufacturing	19.9	29.9	28.1	32.1	12.5	14.3
Transportation, Communications, Utilities	6.3	6.3	5.8	5.6	9.9	8.7
Wholesale, Retail Trade	30.4	25.0	27.4	26.4	29.0	29.2
Services, including F.I.R.E.	30.3	25.2	23.2	23.7	30.1	29.3
Government	6.1	6.1	10.5	4.4	2.3	2.7

*Totals of industry percentages may not equal 100 due to rounding.
**With the exception of mining, coastal area totals do not include data reported as statewide. For mining, a percentage of the data reported as statewide is included in the total (Alabama, 40%; Mississippi, 15%; and Louisiana, 65%).

Source. USDC, Bureau of the Census, 1985.

Table III-8

Employment by Major Industry Group*
Western Gulf of Mexico - 1983 Percent of Total

	Texas Coastal Area	State (Texas)
Agriculture, Forestry, Fishing	0.5	0.4
Mining**	6.0	4.6
Contract Construction	9.0	8.3
Manufacturing	17.0	18.5
Transportation, Communications, Utilities	7.6	6.6
Wholesale, Retail Trade	27.4	28.8
Services, including F.I.R.E.	30.5	29.5
Government	1.8	3.2

*Totals of industry percentages may not equal 100 due to rounding.

**With the exception of mining, coastal area totals do not include data reported as statewide. For mining, 40% of data reported as statewide is included in the total.

Source: USDC, Bureau of the Census, 1985.

Table III-9

Income Data
Gulf of Mexico Region

	Per Capita Personal Income (thousands $)				Total Personal Income (billions $)			
Area	1970	1978	1983	% Change 1978-1983	1970	1978	1983	% Change 1978-1983
Alabama	3.0	6.3	9.2	46.0%	1.1	2.8	4.2	50.0%
Mississippi	3.2	6.1	8.8	44.3%	0.8	1.8	2.9	61.1%
Louisiana	3.3	7.5	11.4	52.0%	7.0	17.5	30.1	72.0%
Texas	3.9	8.7	12.6	44.8%	12.0	33.5	60.5	80.6%
Gulf Region	3.5	7.9	11.9	50.6%	20.9	55.6	97.7	75.7%
United States	3.9	7.9	11.7	48.1%	801.0	1,717.0	2,734.5	59.3%

Sources: USDC, Bureau of Economic Analysis, 1977; 1980.
USDC, Bureau of Economic Analysis, 1985.

3. Population

Table III-10 shows population changes in the Gulf region for 1970, 1980, and 1983, when growth over this period was substantial. All states experienced growth rates well above the national level. Table III-11 gives the net migration data for the 1980-1982 period.

Central Gulf of Mexico

In Alabama, Mississippi, and Louisiana, the net migration rates from 1980-1982 are 1.0%, 2.5%, and 1.8%, respectively. Included in this figure could be migration from one coastal county to another coastal county in the same state.

Western Gulf of Mexico

In Texas, the net migration figure increased the most to 6.2% or 82% of the Gulf region. Included in this figure could be migration from one coastal county to another coastal county in the same state.

4. Coastal Management Programs

The Central and Western Gulf of Mexico regions are made up of four coastal states. Three of the four states have Federally approved coastal management programs (CMP). The three states are Alabama, Mississippi, and Louisiana. The fourth state, Texas, conducts coastal management affairs independent of the Federally sponsored coastal zone management planning program.

Regional planning units, made up of a number of cities and counties/parishes, exist in each state. These planning organizations generally conform to state CMP policies and expand these policies into plans and implementation recommendations. A state by state description of CMP policies and a listing of the regional planning units in each state follows:

Central Gulf of Mexico

Alabama Coastal Area Management Program (ACAMP)

The Alabama Coastal Area Act (ACAA) of 1976, as amended in 1982 by the Alabama Environmental Management Act (AEMA), divides implementation of coastal resource management between two State agencies: the Department of Environmental Management (DEM) and the Department of Economic and Community Affairs (DECA). The ACAA and the AEMA provides statutory authority to DEM to review all uses which have a direct and significant effect on the coastal area and require a state permit. DEM's permitting authority must be consistent with approved state policies, rules, and regulations. All coastal area program planning policy formulation, coordination, and resource research and study are performed by DECA. Both permitting and planning functions were formerly conducted by the Coastal Area Board until legislative amendments dissolved the Board and reassigned responsibilities in 1982.

State Policies

The Alabama Coastal Area Act of 1976 states the following purpose: ". . . to promote, improve and safeguard the lands and waters located in the coastal areas of this State through a comprehensive and cooperative program designed to preserve, enhance, and develop such valuable resources for the present and future well-being and general welfare of the citizens of this State." Statutory policies supporting coastal zone management are detailed in Section III.C.5. of Final EIS 94/98/102. The policies are concerned with coastal land and water resource conservation, harbor facilities, and intergovernmental cooridnation and cooperation.

To provide guidelines for implementation of its enforcement authorities, the state has issued enforceable policies and operational rules. Basically, there are two types of policies: (a) policies for coastal resources uses and (b) policies for natural resource protection. In addition, operational rules, regulations, and action items which further elaborate on these policies have been adopted.

Table III-10

Population Data
Gulf of Mexico Region
(thousands)

Area	1970	1980	1983*	% Change 1970-1983	Average Annual Growth Rate 1970-1983
Alabama	376.7	443.5	459.1	21.9%	1.7%
Mississippi	248.0	309.9	328.8	32.6%	2.5%
Louisiana	2,141.9	2,477.9	2,633.5	23.0%	1.8%
Texas	3,104.4	4,286.5	4,784.3	54.1%	4.2%
Gulf Region	5,871.0	7,517.8	8,205.7	39.8%	3.1%
United States	203,312.0	226,504.8	233,974.8	15.1%	1.2%

*Derived from total personal income and per capita income data.

Sources: Environmental Consultants, Inc., 1974.
USDC, Bureau of the Census, 1982.
USDC, Bureau of Economic Analysis, 1985.

Table III-11

Net Migration Data
Gulf of Mexico Region

Net Migration 1980-1982*

Area	Number (thousands)	Rate**	Migration as a Percent of the Gulf Region
Alabama	4.5	1.0%	1.3%
Mississippi	7.9	2.5%	2.4%
Louisiana	45.2	1.8%	13.9%
Texas	267.5	6.2%	82.0%
Gulf Region	325.1	4.3%	100.0%

*This is the latest year for which data are available.
**Rate is expressed as a percent of the 1980 total population (from previous table).

Source: USDC, Bureau of the Census, 1980, 1982, and 1984a, b, c, d, and e.

Coastal resource use policies deal with coastal development, mineral resources exploration and extraction, commercial fishing, hazard management, shoreline erosion, recreation, and transportation. Natural resource protection policies deal with biological productivity, water quality, water resources, air quality, wetlands and submerged grassbeds, beach and dune protection, wildlife habitat protection, endangered species, and archaeological resources protection.

Special management areas may be delineated under authority of the ACAMP. There are two types of special management areas: geographic areas of particular concern (GAPC) and areas for preservation and restoration (APR). Designated GAPC's are the Port of Mobile and the Mobile-Tensaw River Delta. APR's are Point aux Pins Wetlands System and the National Audubon Society Wildlife Sanctuary.

The South Alabama Regional Planning Commission serves local governments in the coastal area in an advisory capacity. It has no direct management role in coastal zone matters.

Mississippi Coastal Program

The Mississippi Coastal Program (MCP) is administered by the Mississippi Commission on Wildlife Conservation through the Bureau of Marine Resources (BMR). The primary coastal management statute is the Coastal Wildlife Protection Law (Mississippi Code, Section 49-27-1). The authorities of certain other agencies are incorporated into the MCP pursuant to the Mississippi Code (Section 57-16-6) which requires the coastal program to incorporate "all of coastal Mississippi." BMR, the Bureau of Pollution Control, the Bureau of Land and Water Resources, and the Department of Archives and History are identified collectively as the "coastal program agencies." The Mississippi Commission on Wildlife Conservation, acting through BMR, consolidates authorities previously assigned to the Marine Resources Council and the Marine Conservation Commission, including authority to study and develop plans, proposals, reports, and recommendations for the development and utilization of the coastal and offshore lands, waters, and marine resources of the state. Additional statutory authorities supporting MCP are listed in Table III-11 of Final EIS 94/98/102.

The scope of the Mississippi Coastal Program is built around 10 stated goals. The goals are described in Table III-12 of Final EIS 94/98/102 along with the State agency having lead responsibility in meeting the goal. The program goals are concerned with achieving industrial expansion, preserving coastal wetlands, improving aquatic life, conserving air and water, preserving historical and archaeological resources, encouraging scenic qualities, supporting public facilities and the national interest, and fostering intergovernmental coordination. As stated in MCP, these goals are intended to promote decisions that balance development with the environment.

State Policies

Mandatory and enforceable policies of MCP are established primarily through direct State agency authorities for the management of coastal wetlands, management of coastal fisheries, air and water pollution control, management of surface and groundwater resources, and protection of archaeological resources. Each of these elements of MCP is based on provisions of the Mississippi Code, which require applications for state permits and compliance with adopted State Regulations.

Policies of the state associated with MCP, as stated in Mississippi Codes, are detailed in Section III.C.5. of Final EIS 94/98/102. The policies are concerned with the preservation of coastal wetlands, reasonable industrial expansion, the national interest, the historical and archeaological resources, conservation of aquatic life, and air and water resource management.

The program also provides for the designation of Special Management Areas (SMA's) and the adoption of management plans for such areas. SMA designation does not create new regulatory authority, but does commit the general regulatory provisions of the program to the implementation of SMA plans.

The MCP identifies certain "affirmative management activities." Energy facilities are recognized as likely developments in coastal areas and the MCP provides for State assistance "to local governments to plan and build facilities required as a result of energy developments." Shoreline erosion is identified as a matter of special concern to be addressed primarily through wetlands permitting. Marine fisheries research, identification of areas for "preservation and restoration" through wetlands use planning, improved coordination and processing of required coastal area permits, preservation of natural scenic qualities, and public education are other objectives addressed through MCP policies and regulations.

Two regional organizations are at work in the coastal region of the state. They are the Southern Mississippi Planning and Development District and the Gulf Regional Planning Commission. In addition, MCP activity is conducted with city and county government, local industrial development districts, and various substate agencies, cities, and counties.

Louisiana Coastal Resources Program

The basis for the Louisiana Coastal Resources Program (LCRP) is Act 361, the State and Local Coastal Resources Management Act of 1978 (La. R.S. 49:213.1). The Act puts into effect a set of state coastal policies and coastal use guidelines that apply to coastal land and water use decisionmaking. A number of existing state regulations are also incorporated into the program, including those concerned with oil and gas and other mineral operations; leasing of state lands for mineral operations and other purposes; waterbottom pipelines; hazardous waste and radioactive materials; management of wildlife, fish, other aquatic life, and oyster beds; endangered species; LOOP; and air and water quality.

The Act also authorized establishment of Special Management Areas (SMA's). Included or planned to be included as SMA's are: LOOP, Marsh Island, artificial barrier islands to protect deteriorating coastal areas, and freshwater and sediment diversion projects to offset land loss and saltwater encroachment.

The coastal use guidelines are based on seven general policies outlined in Act 361. They are implemented through coastal use permits and in-lieu permits. In-lieu permits provide for the use of permit requirements existing before the Act took effect to fulfill the role of coastal use permits, thereby avoiding duplicative permitting procedures.

Act 361 identified a number of uses of state concern subject to coastal use permitting requirements. Uses of state concern listed in Act 361 which could be relevant to a sale and its possible direct effects and associated and nonassociated facilities are: (a) any dredge and fill activity which intersects more than one water body; (b) projects involving the use of state-owned lands or water bottoms; (c) national interest projects; (d) pipelines; and (e) energy facility siting and development.

State Policies

The Legislature declared the public policy of the state to be described by seven policy statements detailed in Section III.C.5. of Final EIS 94/98/102. The policies are concerned with protecting and enhancing coastal land and water resources, maintaining regulatory control over coastal activities, supporting multiple use of coastal resources including recreation, and implementing a coastal resource management plan. The implementation of these policies was provided for by the state legislature in Section 213.8 of Act 361. This section allows for the promulgation of coastal use guidelines. The coastal use guidelines are the criteria for granting or denying coastal use permits.

Existing state regulatory provisions incorporated into the LCRP include those which address: (a) oil, gas, and mineral operations; (b) state lands management; (c) transportation, storage, and disposal of hazardous waste; (d) use and disposal of radioactive materials; (e) management of wildlife, fish, and other aquatic life; (f) management of oyster bedding grounds; (g) water quality; (h) resident endangered or threatened species; (i) construction and operation of offshore terminal facilities; (j) construction, operation, and abandonment of water wells; and (k) air quality. Where appropriate and applicable, requirements under these existing state regulatory measures have been incorporated into the various coastal use guidelines identified above. A careful examination of the LCRP indicates that aside from the coastal use guidelines, existing State water and air quality provisions (La. R.S. 30:1068, 1081-1087, 1091-1096, 38:216) are applicable to the possible direct effects and associated or nonassociated facilities connected with oil and gas activities.

Four Regional Planning Councils (RPC) are involved with the coastal area of Louisiana. The RPC's act in an advisory capacity to local units of government, State agencies, and local groups. The RPC's are listed in Section III.C.5. of Final EIS 94/98/102.

Texas Coastal Management Program

In May 1981, the State of Texas formally withdrew from the Federally sponsored coastal zone management program. In place of a coastal zone management plan with certain mandated features of the Coastal Zone Management Act of 1972, Texas has a network of 14 State agencies involved in the regulation of coastal resources. This network is held together by a memorandum of understanding (MOU) between State agencies. The MOU exists to accomplish the following:

(a) improve coordination between State agencies;

(b) require State agencies to collect data and conduct impact assessments in order to approve, deny, or conditionally approve proposed projects; and

(c) to encourage State agencies to participate on a voluntary basis so as to avoid a duplication of effort, overlaps, and conflicts between agencies.

The Texas state coastal zone management program is decentralized. The General Land Office of Texas, operating under authority vested in an elected commissioner by the Texas Coastal Public Land Management Act of 1973, coordinates the permitting system conducted by the state. The General Land Office reviews and recommends actions to be taken based on permit applications received from the U.S. Army Corps of Engineers and Texas State agencies with statutory permitting authority. The program area of jurisdiction is public land/waters under tidal effect including bays, rivers, and the Gulf of Mexico out to the three league line. Most of the activities reviewed have to do with oil and gas development, dredging, and spoil areas.

State Policies

Since no formal coastal zone management program (in the context of CZMA) exists in Texas, no formal policies associated with a program may be cited. Policies and permitting procedures have been established to implement coastal resources management on an agency by agency basis, and a voluntary coordination mechanism is in operation by the General Land Office of Texas.

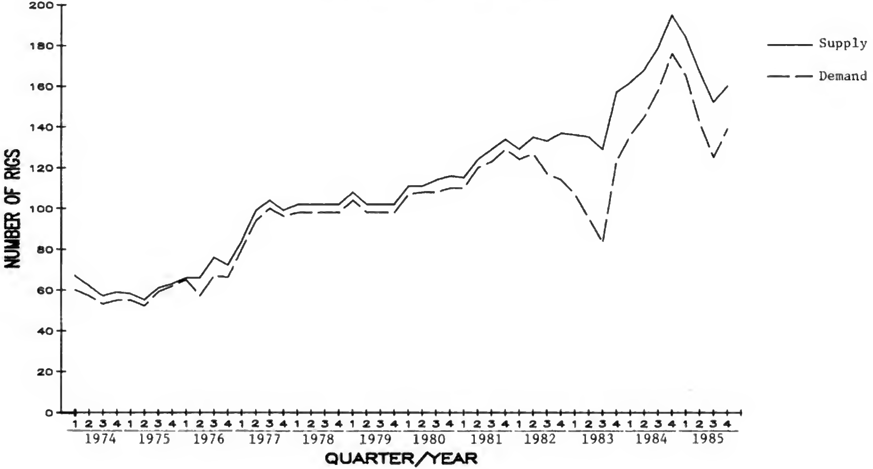
Five regional planning units are operating in the Texas coastal area. These Councils of Government (COG) provide technical assistance to their member cities and states. In the face of limited regulatory powers, COG's have a limited impact on coastal resource management.

5. Oil and Gas Industry

The infrastructure for oil and gas production in the Gulf of Mexico is the most developed in the world. It includes oil refineries, petrochemical and gas processing plants, supply bases for offshore services, platform construction yards, pipeline yards, and other industry-related installations. This infrastructure is highly concentrated in the coastal areas of Louisiana and eastern Texas and to a lesser extent along the southern half of the Texas Gulf coast. To the east, the infrastructure is found as far as Mobile, Alabama. Visual No. 7 provides a graphic display of the extent and concentration of this Gulf region infrastructure. Sections IV.A.2.a. and b. include a more detailed description of production operations, infrastructure, and other activities related to the oil and gas industry in the Gulf of Mexico.

The Gulf of Mexico offshore oil and gas industry has experienced dramatic changes over recent years. Figures III-3, III-4, and III-5 illustrate the trends in Federal offshore mobile rig utilization, leased Federal OCS acreage, and U.S. hydrocarbon wellhead prices, respectively, These graphs, which cover the 1974-1985 period on a quarterly basis, clearly indicate the volatility of the offshore industry since 1981. The Federal offshore mobile rig demand dropped considerably from the end of 1981 to mid-1983. This was due primarily to a drop in wellhead prices resulting from excess supplies of oil and gas. In the midst of this decline, however, industry continued to expand its capacity in response to earlier years of growth. The net result was a rapid and significant gain in industry

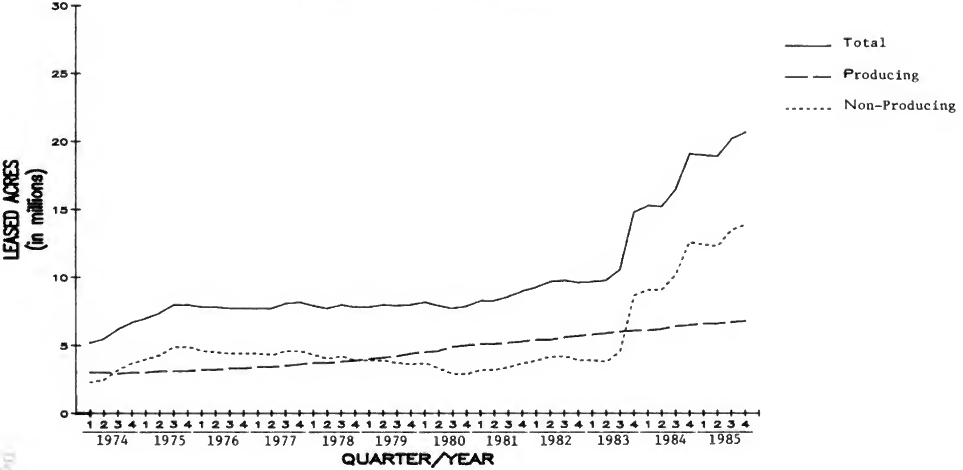
MOBILE RIG UTILIZATION INDEX
Gulf of Mexico
1974 to 1985



Source: Monthly Report and Quarterly Report, January 1974 through December 1985.

Figure III-3

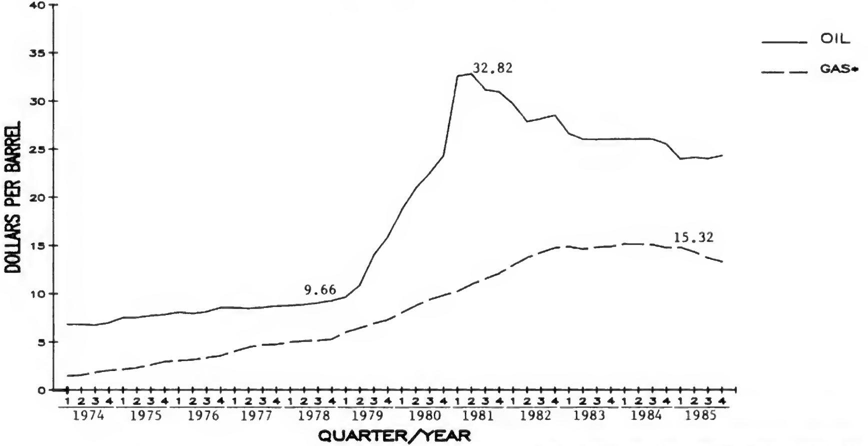
LEASED OCS ACREAGE
Producing and Non-Producing
1974 to 1985



Source: Monthly Report and Quarterly Report, January 1974 through December 1985.

Figure III-4

HYDROCARBON WELLHEAD PRICES
Crude Oil and Natural Gas
1974 to 1985



*1 bbl=5.65 mcf natural gas heating capacity

Source: US DOE, Energy Information Administration. Monthly Energy Review. US DOE, Bureau of Mines, Minerals and Materials. A Monthly Survey.

Figure III-5

overcapacity over that period. In mid-1983, however, the Federal Government's institution of its areawide offshore leasing program provided a significant boost to this declining industry. Offshore rig utilization increased dramatically from mid-1983 through the fourth quarter of 1984 as a direct result of the large areawide offshore Federal lease sales of 1983 and 1984. By the first quarter of 1985, however, the recognition of a continued excess supply of oil and gas, which was resulting in continually dropping oil and gas wellhead prices, halted this growth of offshore drilling activity in the Gulf of Mexico. Despite continued offshore Federal areawide lease sales in the Gulf of Mexico, offshore drilling has dropped significantly over 1985 and is expected to continue to do so through the early part of 1986, at a minimum. The current situation is an offshore sector which has a significant overcapacity of equipment and labor. This is expected to continue until the wellhead price of oil and gas reaches a higher and more stable level.

The production of crude oil and gas may be classified as a primary industry while the further processing of oil and gas in refineries, natural gas plants, and petrochemical plants may be considered as secondary industries. Existing facilities appear adequate to accommodate significant growth in both primary and secondary industries within the region.

OCS oil and gas production, particularly in Louisiana, has been a major source of employment and revenues in the study area since 1954. Approximately 140,000 jobs are directly or indirectly dependent on the offshore program. Approximately 115,000 of these jobs are associated with activity in the Central Gulf and 25,000 are related to the Western Gulf. Virtually all offshore-related employment in the Central Gulf is due to activity offshore Louisiana. Estimates of direct employment offshore in 1983 were as follows: 50,000 workers in the Central Gulf and 10,000 workers in the Western Gulf. The average annual payroll associated with oil and gas activities amounts to approximately $3.0 billion for the Gulf coast region ($2.3 billion for the Central Gulf and $0.7 billion for the Western Gulf). Average annual tax dollars generated per employee in the offshore oil and gas program are estimated at 8% of payroll revenues. The total amount of state and local taxes generated annually by the Federal offshore oil and gas program is estimated at $180.4 million from the Central Gulf and $59.2 million from the Western Gulf.

From 1982-1983, production of oil and condensate in Louisiana increased by 5%; however, the value of that oil decreased by 2% to $8.7 billion in 1983. Production of natural gas in Louisiana decreased by 19% in that period, while the value of that natural gas decreased by 17% to $8.4 billion in 1984.

From 1983-1984, there was an increase of 8.4% in the value of oil and condensate ($10 billion) and an increase of 16% in the value of natural gas produced off Louisiana ($10 billion).

From 1982-1983, production of oil and condensate in Texas increased by 12%, while the value of that oil only increased by 6% to $0.6 billion. Production of natural gas in Texas decreased by 3% in that period; however, the value of that gas increased by 9% to $2.5 billion.

From 1983-1984, there was an increase of 8% in the value of oil and condensate produced off the Texas coast ($0.7 billion) and an increase of 18% in the value of natural gas and entrained liquids ($3 billion).

The cumulative value of oil and condensate produced offshore Louisiana and Texas from 1953-1984 was $67.1 billion and $2.6 billion, respectively. The cumulative value of gas and entrained liquids produced offshore Louisiana and Texas from 1953-1984 was $65.2 billion and $12.6 billion, respectively.

Selected Standard Industrial Classification (SIC) codes serve to further identify the extent of employment in the oil and gas industry. These are:

13 - oil and gas extraction
29 - petroleum and coal products
3533 - oil field machinery
46 - petroleum pipelines
492 - gas production distribution
517 - petroleum and petroleum products

SIC 13 is considered the primary industry while the others indicate secondary industries. Other SIC codes include some OCS-related secondary industries within broader categories of data that are excluded from this analysis (particularly SIC 3731, which includes shipbuilding and mobile rig fabrication). Tertiary (induced) industries are not included. Table III-12 gives the approximate levels of employment and payroll data for these selected SIC codes in the Gulf region (onshore and offshore combined) for 1983. Note the substantial level of employment in the secondary industries in the Texas and Louisiana coastal zones. The data are reported by establishments according to place of work, although the data include a portion of the County Business Patterns data reported as "statewide" to

Table III-12

Employment and Payroll Data[1]
Selected Oil and Gas SIC Codes
Gulf of Mexico Region (1983)

Area	SIC 13 No. of Employees	SIC 13 Payroll per Employee	Aggregate SIC's 29, 3533, 46, 492, 517 No. of Employees	Aggregate SIC's 29, 3533, 46, 492, 517 Payroll per Employee
Alabama	735	$28,589	1,605	$16,044
Mississippi	563	-[2]	2,125	$12,000
Louisiana	49,162	$27,559	18,840	$20,694
Texas	83,038	$29,069	74,038	$27,214
TOTAL	133,498	-[3]	96,608	-[3]

[1] When a range for the employment data was given, the mid-point was used. Payroll estimates were made using only data disclosed for both employment and payrolls. For Louisiana and Texas, SIC 13 data include a portion of the County Business Patterns data reported as "statewide" to account for offshore employment and payroll. For Alabama and Mississippi, however, none of the data reported as "statewide" have been included due to lack of information on which to base apportionment.

[2] Payroll data for Mississippi was not disclosed.

[3] Not applicable.

Source: USDC, Bureau of the Census, 1985.

Table III-13

Import-Export Data (from vessels)
Gulf of Mexico Region (1983)

Area (U.S. Customs District)*	Exports Million $	Exports Million Lbs.	Exports Rank ($)	Imports Million $	Imports Million Lbs.	Imports Rank ($)
Mobile	1,399.0	13,559.7	6	2,053.9	21,208.9	5
New Orleans	18,137.6	193,362.6	1	13,784.0	117,314.1	2
Port Arthur	1,539.5	20,430.0	5	4,251.0	39,192.5	3
Houston/Galveston	13,220.2	68,018.8	2	19,506.1	133,330.7	1
United States	100,829.7	723,910.0		155,921.7	753,731.3	

*Ports of Entry in each U.S. Customs District include: Mobile District-Gulfport, Pascagoula, Mobile, Pensacola, Panama City, Port St. Joe, Apalachicola, Carrabelle; New Orleans District-New Orleans, Baton Rouge, Morgan City; Port Arthur District-Port Arthur, Beaumont, Orange, Lake Charles; and Houston/Galveston District-Houston, Galveston, Freeport, Port Lavaca-Point Comfort, Corpus Christi.

Source. USDC, Bureau of the Census, 1983.

account for offshore employment and payroll. Employment in SIC 13 is reported for all counties in Texas except three (Cameron, Kenedy, and Willacy) and for all parishes in Louisiana except four (Livingston, St. James, St. Tammany, and West Baton Rouge). For Alabama, SIC 13 data are reported for only one county (Mobile), and for Mississippi, no SIC 13 data are reported for any county.

6. Ports and Marine Transportation

Ports serving waterborne commerce along the Gulf coast include some of the busiest in the Nation. Table III-13 provides a breakdown of the dollar value and poundage of exports and imports shipped to and from the four Customs Districts in the CPA and WPA in 1983. The New Orleans district ranked first in the dollar value of exports in the Gulf and in the entire Nation. The Houston/Galveston district ranked first in value of imports in the Gulf and third nationally.

In addition to the major ports, there are numerous smaller ports involved in waterborne commerce. Table III-14 contains an aggregation by planning and analysis area of the commodity short tonnage transported by vessel through the harbors and waterways providing access to selected ports along the Central and Western Gulf coast in 1983. The majority of this activity, 53%, occurred in the WPA.

Many of the ports in the CPA and WPA are involved in activities associated with the exploration, development, and production of oil and gas in the Gulf. Some of the areas have developed into important centers for offshore support. The most active of these are, from east to west, Venice, Morgan City, Intracoastal City, and Cameron in Louisiana and Sabine Pass, Port O'Connor, and the Ingleside-Aransas Pass-Port Aransas area in Texas. The locations of these and other ports involved in the offshore industry are shown on Visual No. 7.

A heavily used shipping pattern has developed in the Gulf. Ships crossing open Gulf waters often utilize a system of established safety fairways as shown on Visual No. 11 and previously discussed in Section I.B.4.a. These fairways connect the major Gulf ports including the deepwater oil terminal LOOP which is located offshore Louisiana (Section I.B.6.b.). Regulations prohibit the placement of fixed structures in fairways, thus providing clear passages of 2 nmi in width through the developed areas of the Gulf. Vessels operating along the coast generally use the Gulf Intracoastal Waterway (GIWW) which follows the coastline inshore and through bays and estuaries from Fort Myers, Florida, to Brownsville, Texas.

Table III-14 also indicates the number of vessel trips to and from ports in the CPA and WPA made by vessels with drafts greater than 18 ft and those with drafts less than or equal to 18 ft. Vessels with drafts greater than 18 ft are generally ocean going bulk cargo ships and oil tankers, which have the most potential for conflict with OCS oil and gas activities and structures. Many of the shallower draft vessels, especially barges, use the GIWW.

The net change in total trips since 1982 indicates a dramatic decrease of 57% in the number of trips to and from ports in the CPA in 1983. Much of this decrease is apparently due to reductions in oil- and gas-related vessel traffic.

7. Military Use/Warning Areas

Central Gulf of Mexico

Ten percent, or 4,078,000 acres, of water and air space of the Central Gulf is used for the various military operations within three warning areas and water test areas. Warning Area 453 is an Air National Guard training area, Warning Area 92 is a Naval Air Reserve training area, and Warning Area 155 is a Navy training area. In these areas, use is infrequent and intermittent.

An intensive use of W-92 or W-453 or the water test areas has not been indicated by the Navy or Air Force in the past. All three areas have had very little oil and gas development. Warning area 155 is used by the Navy for carrier maneuvers and carrier pilot training. Although W-155 has had very little oil and gas development within it, the Navy has indicated that W-155 has a continuous and intensive use, and that the Navy is concerned that future oil and gas exploration and development facilities may seriously restrict their operations in the area.

Table III-14

1983 Central and Western Gulf of Mexico Freight and Vessel Traffic

		Vessel Traffic to and from Port/Harbor/Waterway			
Port/ Harbor/Waterway	Freight Traffic (short tons)	Draft Greater Than 18′	Draft Less Than or Equal to 18′	Total Trips	Net Change from Total Trips in 1982
		Central Gulf			
Subarea C-1					
Calcasieu River and Pass	21,783,071	1,125	17,702	18,827	-13,987
Mermentau River	1,065,503	–	4,075	4,025	- 237
Freshwater Bayou	303,515	–	2,788	2,788	- 1,220
C-1 Total	23,152,089	1,125	24,565	25,690	-15,444
Subarea C-2					
Atchafalaya River	5,271,667	–	14,512	14,512	- 7,239
Houma Navigation Canal	1,210,832	–	10,873	10,873	- 2,246
Bayou Lafourche and Lafourche Jump Waterway	663,500	–	10,631	10,631	-11,264
C-2 Total	7,145,999	–	36,016	36,016	-20,749
Subarea C-3					
Barataria Bay Waterway	1,013,508	–	5,363	5,363	- 6,992
Empire to Gulf	759,967	–	10,065	10,065	-17,337
Port of New Orleans (freight only)	156,272,189	–	–	–	–
Mississippi River Passes (trips only)	–	14,235	16,478	30,713	- 742
Mississippi Gulf Outlet (trips only)	–	1,288	4,134	5,422	-12,997
C-3 Total	158,045,664	15,523	36,040	51,563	-38,068
Subarea C-4					
Pearl River (LA and MS)	64,308	–	106	106	+ 32
East Pearl River	97,161	–	202	202	- 14
Cadet Bayou	–	–	4	4	- 1,176
Wolf and Jordan Rivers	41,015	–	120	120	+ 57
Pass Christian Harbor	–	–	15	15	- 9,159
Gulfport	1,147,970	460	611	1,071	- 1,137
Biloxi	1,479,598	–	8,578	8,578	- 937
Pascagoula	20,327,662	824	10,303	11,127	- 4,001
Bayou LaBatre	3,234	–	1,706	1,706	- 216
Bayou Coden	–	–	–	–	- 4,928
Dauphin Island Bay	–	–	4	4	- 11
Mobile Harbor	29,690,361	1,530	25,995	27,525	- 2,732
Bon Secour River	7,752	–	1,760	1,760	- 192
Perdido Pass	2,835	–	5,882	5,882	+ 220
C-4 Total	52,861,896	2,814	55,286	58,100	-24,194
CPA Total	241,205,648	19,462	151,907	171,369	-98,455
		Western Gulf			
Subarea W-1					
Brownsville	1,338,550	147	1,111	1,258	- 457
Port Isabel	284,758	1	1,763	1,764	- 40
Corpus Christi Ship Channel	39,131,318	1,637	14,887	16,524	+ 944
Matagorda Ship Channel	3,422,854	225	911	1,136	+ 10
W-1 Total	44,177,480	2,010	18,672	20,682	+ 457
Subarea W-2					
Freeport Harbor	15,671,990	1,006	4,397	5,403	- 11
Galveston Channel	6,938,491	1,388	2,253	3,641	- 495
Texas City Channel	35,496,241	1,387	12,536	13,923	- 325
Houston Ship Channel	88,706,519	7,310	53,269	60,579	- 1,053
Sabine-Neches Waterway	80,771,470	2,623	57,840	60,463	+ 1,180
W-2 Total	227,584,711	13,714	130,295	144,009	- 704
WPA Total	271,762,191	15,724	148,976	164,691	- 247
CPA and WPA Total	512,967,839	35,186	300,878	336,060	-98,702

Source. U.S. Dept. of the Army, Corps of Engineers, 1984a.

Warning Areas	Defense Operations Conducted
W-92	Air-to-air gunnery, rocket firing, sonar buoy operations
W-453	Air National Guard training
W-155	Carrier maneuvers, carrier pilot training
EWTA-1	Rocket and missile testing and research
EWTA-3	Rocket and missile testing and research

Western Gulf of Mexico

Thirty-seven percent, or 12,000,000 acres, of water and air space of the Western Gulf of Mexico is used for the various military operations within two warning areas. Warning area 602 is used extensively from the surface to 45,000 ft for a myriad of training profiles that include live firing aerial gunnery, trailing wire antenna activity, flares and chaff drops/tests, and B-52G-model low level flights. However, the Air Force has not indicated an intensive use of W-602. Because it lies mostly over deeper waters, Warning Area 602 has had oil and gas development only in the northern one-third of the area. Warning Area 228 has been intensively used by the Navy for carrier maneuvers and carrier pilot training, and has had considerable oil and gas activity take place within it.

Warning Areas	Defense Operations Conducted
W-228	Air-to-air gunnery, rocket firing, aircraft carrier operations, submarine operations
W-602	High altitude training

8. Commercial Fishing Industry

The Gulf of Mexico is a very important fisheries production area with total annual landings averaging over two billion pounds, valued at over $600 million dockside (USDC, NMFS, 1985a). The Gulf shrimp fishery represents the single most valuable fishery with landings (heads removed) averaging approximately 200 million lbs/yr, worth about $300 million. The menhaden purse seine fishery is the most important fishery in terms of pounds landed with landings ranging from about 1,000-1,200 million lbs/yr, worth about $40-$45 million. About 50 species of finfish contribute to the total Gulf food finfish landings that average about 112.5 million lbs/yr, worth about $26.3 million. Oyster landings approximate 15 million lbs/yr, valued at $13 million. About 40 million lbs of blue crabs are landed annually, worth about $5-$6 million.

In 1982, there were about 34,000 fishermen operating 18,900 crafts of various sizes in the Gulf region. In 1983, there were 897 processing and wholesale plants in the area that employed over 13,969 people (USDC, NMFS, 1985a). The Gulf region's processed fishery products amount to over $660 million annually and represent about 20% of the comparable United States total. About 65% of the value of processed products is related to shrimp production; menhaden ranks second with 11%. About 70% of all Gulf processing involves frozen packaged items followed by industrial products at 12%, canned items at 11%, and fresh products at 7%.

Tables III-15 and III-16 show the total catch (excluding freshwater species) and total value of the catch (dockside) for some NMFS grid zones and MMS analysis areas, respectively. For a more detailed description of the commercial fishery industry in the Gulf of Mexico, see Volume 1, Section III.C.6. of the Final Regional EIS and Visual No. 4-I. For a depiction of the analysis areas, see Figure IV-1.

Table III-15

Catch by National Marine Fisheries Service Grid Zone

AVERAGE CATCH 1977-1981
(million pounds and million dollars)

	Total		Inshore	
Grid Zone	Pounds	Dollars	Pounds	Dollars
11	171.6	35.5	150.9	15.9
12	210.8	24.9	208.7	22.6
13	182.7	55.6	17.1	13.1
14	46.8	37.5	16.6	17.4
15	374.4	61.0	11.2	2.6
16	300.9	41.1	4.5	3.0
17	299.1	38.0	0.4	0.1
18	27.8	36.2	8.6	9.5
19	28.5	50.5	16.3	13.1
20	11.9	27.8	3.7	3.4
21	8.3	21.1	1.4	0.7

(See Visual No. 2 for a depiction of the grid zones.)

Source. Tidwell, 1983.

Table III-16

Catch by MMS Analysis Area*

(million pounds and million dollars)

	Total		Inshore	
Analysis Area	Pounds	Dollars	Pounds	Dollars
Central Gulf of Mexico				
C-4	117.9	22.1	105.1	11.5
C-3	422.3	85.8	270.8	38.6
C-2	378.1	95.5	28.4	21.6
C-1	568.0	77.7	6.9	3.6
Western Gulf of Mexico				
W-2	148.5	80.0	18.6	17.5
W-1	31.4	68.8	11.6	9.3

*Based on Catch by Grid Zone (Table III-15).

9. Recreational Activities

The northern Gulf of Mexico coastal zone is one of the major recreational regions of the United States, particularly in connection with marine fishing and beach-related activities. The shorefronts along the Gulf coasts of, Alabama, Mississippi, Louisiana, and Texas offer a diversity of natural and developed landscapes and seascapes. The coastal beaches, barrier islands, estuarine bays and sounds, river deltas, and tidal marshes are extensively and intensively utilized for recreational activity by residents of the Gulf south and tourists from throughout the Nation, as well as from foreign countries. Publicly-owned and administered areas such as National seashores, parks, beaches, and wildlife lands, as well as specially designated preservation areas such as historic and natural sites and landmarks, wilderness areas, wildlife sanctuaries, and scenic rivers attract residents and visitors throughout the year. Commercial and private recreational facilities and establishments, such as resorts, marinas, amusement parks, and ornamental gardens, also serve as primary interest areas and support services for people who seek enjoyment from the recreational resources associated with the Gulf. Visual No. 3 provides a synoptic view of the location, extent, and components of the recreational resources in the coastal and offshore areas of the CPA and WPA.

The two major recreational areas most directly associated with offshore leasing and potentially affected by it are the offshore marine environment and the coastal shorefront of the adjoining states. The only major recreational activity occurring on the OCS is offshore marine recreational fishing. Studies, reports, and conference proceedings published by MMS and others have documented a substantial recreational fishery including scuba diving directly associated with oil and gas production platforms (USDI, MMS, 1985a). The recreational fishing associated with oil and gas structures stems from their function as high profile artificial fishing reefs. A preliminary report on the 1984 Marine Recreational Fishery Statistics Survey presented by NMFS at the Sixth Annual Gulf of Mexico Information Transfer Meeting indicates a majority of the offshore recreational fishing in the CPA is directly associated with oil and gas structures. There are currently about 4,000 offshore oil and gas structures in the CPA and WPA. Many other studies (Ditton and Auyong, 1984; Roberts and Thompson, 1983; Ditton and Graefe, 1978; Dugas et al., 1979) have demonstrated that when oil and gas structures are accessible to marine recreational fishermen and scuba divers they are a major attraction for marine recreational activities and are a positive influence on tourism and coastal economics. Interest is high throughout the Gulf of Mexico region to retain selected oil and gas structures in the marine environment as dedicated artificial reefs to enhance marine fisheries when no longer useful for oil and gas production.

As noted on Visual No. 4-II, the coastal shorefront of the CPA and WPA contains extensive public and private park and recreational areas. Most of the recreational activity focused at the Gulf of Mexico shorefront is associated with accessible beach areas. Major recreational beaches are delineated on the front of Visual No. 4-II and individually listed and further described on the back of Visual No. 10. Approximately 150 miles of linear shorefront in the WPA, or over 25% of Texas' exposed shoreline, is composed of major shorefront recreational beaches. Less than 10% of the CPA shorefront is composed of major shorefront recreational beaches; however, the Mississippi and Alabama shorefronts are noted for their extensive recreational beaches. These beaches are a major inducement for coastal tourism, as well as resident recreational activity.

Tourism is a multibillion dollar industry in the Gulf States associated with the CPA and WPA. The tourism industry accounts for over 100,000 jobs and, through tax receipts, provides a major source of revenue for State and local governments. Often times tourism is the primary industry in coastal counties such as Galveston, Texas, where recreational beaches abound. As was noted in a recent investigation of the tourism industry in Harrison County, Mississippi (Veal, 1984), beaches are a major inducement for tourists selecting travel destinations. Therefore, any threat to the quantity or quality of coastal recreation beaches from the OCS leasing and development program may directly or indirectly impact not only beach-related recreational activities but the tourism industry as well. Hence, we are focusing our recreational analysis in Section IV on the impact of Sales 110 and 112 on the major recreational beaches of the CPA and WPA, respectively.

10. Archaeological Resources

Archaeological resources are any objects or features which are man-made or modified by human activity. Significant archaeological resources are either historic or prehistoric and, as defined by 36 CFR 60.6, generally include properties greater than 50 years old which are associated with events that have made a significant contribution to the broad patterns of our history; are associated with the lives of persons significant in the past;

embody the distinctive characteristics of a type, period, or method of construction; represent the work of a master; possess high artistic values; represent a signficant and distinguishable entity whose components may lack individual distinction; or have yielded, or may be likely to yield, information important in prehistory or history.

The State Historic Preservation Officers for all Gulf coast states were contacted and requested to indicate which sites on the National Register of Historic Places within their coastal zones could potentially be affected by OCS leasing activities. These sites, which include historic buildings, forts, lighthouses, and shipwrecks, are depicted on Visual No. 11.

a. Historic

Although most historic archaeological resources on the OCS are shipwrecks, other types of historic sites, such as the Ship Shoal Lighthouse, may occur in Federal waters.

A literature search for reported ship losses and known shipwrecks was conducted as part of the archaeological resources baseline study for the northern Gulf of Mexico (CEI, 1977). From the information provided by this literature search, a breakdown of known shipwrecks and reported losses in the Gulf is given in Table III-17 below.

The figures above indicate that less than 2% of pre-20th century ships reported lost in the Gulf and less than 10% of all ships reported lost between 1500 and 1945 have known locations. Considering the problems with inaccurate wreck reporting, drift and breakup of wrecks, and ships which have been lost but never reported, it becomes apparent that very little is really known about the locations of historic shipwrecks in the Gulf of Mexico.

In order to deal with the management problems of this largely unlocated resource base, a high probability zone for the occurrence of shipwrecks, Zone 1, was proposed by the baseline study (CEI, 1977). This zone was delineated by using geographic factors, such as approaches to seaports, straits, shoals, reefs, and historic shipping routes as indicators of high shipwreck potential.

Once a ship goes down, the spatial distribution of site materials (integrity/preservation of the site) is governed by sea state, water depth, type of bottom, nature of the adjacent coast, strength and direction of storm currents and waves, and the size and type of construction of the vessel.

Required remote sensing surveys on the OCS have recorded evidence of approximately 57 potential wrecks. Ten of these are definite wrecks while the remaining 47 would require further investigation for positive identification. Eighty percent of these possible wrecks were recorded within Zone 1 which, according to the baseline study, is where the highest incidence of shipwrecks should occur.

Central Gulf of Mexico

Based on the information provided by the archaeological resources baseline study, supplemented by information from the quarterly Defense Mapping Agency printout of Nonsubmarine Contacts, MMS records show 51 shipwrecks with known locations in the CPA. Table III-18 lists the wrecks by OCS lease block, and also lists the blocks within which, according to the position accuracy evaluation given in the Defense Mapping Agency printout, the wreck could possibly lie (US, DOD, DMA, 1982).

It should be emphasized that hundreds of other ships from all historic periods are known to have gone down somewhere in the Central Gulf; however, information on the location of these reported wrecks is not sufficient to allow mapping.

According to the baseline study for the northern Gulf, the high probability zone for shipwreck occurrence in the Central Gulf (Zone 1) is very broad, extending to the 80 m contour in some areas (Visual No. 11).

The major factor which would affect the integrity of shipwreck sites in the Central Gulf would be the unconsolidated Holocene deltaic sediments which comprise the bottom sediments in the eastern portion of the planning area. These sediments would provide protection of site components as they settled. An excellent example is provided by the recently excavated eighteenth century Spanish galleon, the *El Nuevo Constante*, off Cameron Parish, Louisiana (El Nuevo Constante, 1981). This wreck displayed excellent preservation of organic materials (e.g., leather, bone, and wood) due to the unconsolidated clays which encapsulated the wreck, creating an anaerobic environment. This type of wreck preservation would not be anticipated in the westernmost portion of the CPA where the bottom sediments range from outcrops of subaerially weathered clay to localized transgressive sand deposits.

Table III-17

Known Shipwrecks and Reported Losses in the Gulf of Mexico

Historic Period	Number of Wrecks*	Location Known**
1500 to 1699 A.D.	146	0
1700 to 1819 A.D.	275	1
1820 to 1899 A.D.	719	10
Total: Pre-20th Century	1,140	11
1900 to 1945 A.D.***	398	90
Unknown Date	51	9
Total: All Periods	1,589	110

* It should be noted that the above numbers are only approximations since many losses of entire fleets are listed as single wrecks and since it cannot be determined whether several wreccks reported by different sources are the same wreck or not.

** Some of the wrecks had such broad locations given (i.e., covering an entire latitude and longitude) that they were not included in the category "location known."

*** Some wrecks from this period include World War II casualties. Although most World War II wrecks may not be considered historically significant at this time, their historic significance in terms of the National Register criteria may have to be addressed within the life of the leases which result from the proposed lease sales.

It should be noted that the above numbers are only approximations since many losses of entire fleets are listed as single wrecks and since it cannot be determined whether several wrecks reported by different sources are the same wreck or not.

Some of the wrecks had such broad locations given (i.e., covering an entire latitude and longitude) that they were not included in the category "location known."

Some wrecks from this period include World War II casualties. Although most World War II wrecks may not be considered historically significant at this time, their historic significance in terms of the National Register criteria may have to be addressed within the life of the leases which result from the proposed lease sales.

Table III-18

Shipwrecks with Known Locations in the Central Gulf

Name	Type	Date Built	Date Sunk	Date Recorded	Block Number	Other Blocks Within Which Wreck Could Lie
C. Strong	Schooner	1882	1916	1917	Lund 775	
W. H. Marston	Schooner	1901	1927	1928	Lund 344	
J. W. Clise	Schooner	1904	1940	1941	Lund 168	
T. H. Wand	Cargo	1906	1919	1920	Atwater 636	
Nokomis	Schooner	1897	1905	1906	Mississippi Canyon 1008	
Paul Harwood	Tanker		1942		Mississippi Canyon 555	
Alcoa Puritan	Cargo		1942	1950	Mississippi Canyon 384	Mississippi Canyon 385, 428, 429
Robert E. Lee	Cargo	1924	1942		Mississippi Canyon 290	Mississippi Canyon 334
Anona	Unknown		1944		Viosca Knoll 830	Viosca Knoll 829, 873, 874
Bayard	Passenger/Cargo		1942	1945	Main Pass 140	
Tulsa	Cargo/Schooner	1909	1943	1943	Mobile 1000	
Unknown	Barge		1920	1943	falls within 3 mile limit	
Lewis Brothers	Schooner		1925	1945	falls within 3 mile limit	
Manhorton	Cargo	1938		1945	falls within 3 mile limit	
Magnolia CG	Gunboat		1945		falls within 3 mile limit	
Carrabelle	Tanker	1920	1942	1950	Lund 671	Lund 626-628, 670, 672
Amapala	Cargo		1942	1950	Lund 453	Lund 408, 409, 452, 454, 496, 497
Gulf Oil	Tanker	1912	1942	1942	Mississippi Canyon 795	Mississippi Canyon 750, 751, 794
Heredia	Cargo	1908	1942	1945	Ship Shoal 216	Ship Shoal 217
R. W. Gallagher	Tanker		1942	1945	Ship Shoal 207	
Gulf Prince	Tanker		1942		Ship Shoal 206	
Gulf Penn	Tanker	1921	1942	1942	Mississippi Canyon 499	Mississippi Canyon 455, 456, 500
Aurora	Tanker		1942		Grand Isle, So. Add. 91	Ewing Bank 393
Sun	Tanker		1942		South Timbalier 136	
Halo	Tanker	1920	1942		South Timbalier 131	
U-166	Submarine		1942	1965	Ship Shoal 187	Ship Shoal 164
					South Timbalier 141	South Timbalier 112
(Alternate Location)	Submarine		1942	1943	Ship Shoal 139	Ship Shoal 116
					South Timbalier 75	South Timbalier 74
Hamlet	Tanker		1942	1945	Eugene Island 237	
Fairhope	Steamer	1899	1918		South Pass 37	
Louisiana	Cargo	1919	1926	1926	South Pass 30	
B. Brewster	Tanker		1942	1945	Bay Marchand 2	Grand Isle 12
El Vivo	Cargo		1945	1945	Grand Isle 16	
Thistle	Unknown		1877		South Timbalier 18	
City of Toledo	Tanker		1942	1945	Eugene Island 94	Eugene Island 95

Table III-18. Shipwrecks with Known Locations in the Central Gulf (continued)

Name	Type	Date Built	Date Sunk	Date Recorded	Block Number	Other Blocks Within Which Wreck Could Lie
Unknown	Unknown			1944	Vermilion 191	South Marsh Island 29
WaWa	Trawler				falls within 3 mile limit	
E. F. Coney	Cargo	1904	1930	1930	East Cameron 64	
Unknown	Unknown			1944	West Cameron 135	
Unknown	Trawler			1943	West Cameron 75	
Leo Huff	Oil Screw	1941	1947	1950	West Cameron 73	
Unknown	Trawler		1943		West Cameron 72	
Dewey	Trawler		1956	1956	falls within 3 mile limit	
Linda	Trawler				falls within 3 mile limit	
El Constante	Galleon		1766	1979	falls within 3 mile limit	
Sheherozada	Tanker		1942	1945	Eugene Island 190	
Unknown	Unknown			1945	Ship Shoal 109	
R. M. Parker, Jr.	Tanker		1942	1945	Ship Shoal 139 South Timbalier 75	Ship Shoal 116 South Timbalier 74
Wm. C. McTamahan	Tanker		1942		South Timbalier 56	South Timbalier 47, 48, 55
David McKevy	Tanker	1921	1942	1945	South Pelto 14	
Paul Warner	Tanker	1921	1942	1945	South Pass 45	South Pass 44, 54, 55
Virginia	Tanker	1941	1942	1945	West Delta 109	
Yuma	Cargo		1926	1945	West Delta 81	

Western Gulf of Mexico

Based on the information provided by the archaeological resources baseline study, supplemented by information from the quarterly Defense Mapping Agency printout of Nonsubmarine Contacts, MMS records show 17 shipwrecks with known locations in the WPA. Table III-19 lists the wrecks by OCS lease block, and also lists the blocks within which, according to the position accuracy evaluation given in the Defense Mapping Agency printout, the wreck could possibly lie (US, DOD, DMA, 1982).

It should be emphasized that hundreds of other ships from all historic periods are known to have gone down somewhere in the Western Gulf; however, information on the location of these reported wrecks is not sufficient to allow mapping.

According to the baseline study for the northern Gulf, the high probability zone for shipwreck occurrence in the Western Gulf (Zone 1) runs very close to the boundary of Texas territorial waters over much of the western portion of this planning area. This zone, however, is much broader in the eastern portion of the planning area, extending to the 40 m contour in some areas (Visual No. 11).

The major factor which would affect the integrity of wreck sites in the Western Gulf would be the unconsolidated Holocene deltaic sediments which comprise the bottom sediments in the central and western portions of the planning area. These sediments would provide some protection of site components as they settled. Preservation would probably not be as good in the easternmost portion of the WPA where the bottom sediments range from outcrops of subaerially weathered clay to localized sand deposits.

b. Prehistoric

From the late Wisconsin maximum low sea stand (approximately 18,000 B.P.) until sea level reached its current high stand (approximately 5,000 to 3,000 B.P.), the OCS was subaerially exposed and inhabitable by terrestrial flora and fauna--including prehistoric man, who is known to have been in the Gulf coast region since about 12,000 B.P. According to the sea level curve proposed for the northern Gulf by Coastal Environments, Inc. (CEI, 1982), sea level would have been approximately -45 m at 12,000 B.P. Therefore, the continental shelf shoreward of the 45 m bathymetric contour (archaeological zones 1 and 2) would have potential for prehistoric sites dating subsequent to 12,000 B.P. Further, since prehistoric sites generally occur in predictable geographic areas, it was proposed in the CEI study that the same areas where sites of a given period occur on land will be the same areas where sites will occur on the now submerged shelf. These geographic areas with a high probability for associated prehistoric sites are listed in Table III-37 of the Final Regional EIS, along with other information on the extent and types of sites to be found in these areas.

Remote sensing surveys which have been required on leases shoreward of the 45 m contour have been very successful in identifying the geographic features (listed in Table III-37 of the Final Regional EIS) having a high probability for associated prehistoric sites .

Regional geologic mapping studies by MMS provide a geologic framework to aid in the interpretation of lease block survey data. This regional framework allows interpretations to go beyond a statement that a relict feature occurs to an assessment of its archaeological potential in terms of its general age, the type of system to which it belongs, and the geologic processes which formed and modified it.

In addition to identifying areas with a high probability for site occurrence, the potential for site preservation must also be considered as an integral part of the predictive model. In general, it may be expected that sites covered by sediments in a low energy environment (i.e., floodplains, bays, lagoons, river terraces, and subsiding deltas) prior to the sea's transgression of the area will have a high degree of preservation. Other protected areas (i.e., depressions, ponds, lakes, and sinkholes) and areas subjected only to low wave energy also would be conducive to site preservation. Sites on relatively steep shelves which were transgressed during periods of rapid rise in sea level may also have better potential for preservation due to the shorter period of time during which sites would have been exposed to shorefront erosion.

Although many specific areas in the Gulf have been identified through lease block surveys as having a high potential for prehistoric sites, these high probability areas have generally been avoided by oil and gas development rather than investigated.

Table III-19

Shipwrecks with Known Locations in the Western Gulf

Name	Type	Date Built	Date Sunk	Date Recorded	Block Number	Other Blocks Within Which Wreck Could Lie
Honduras	Steamer		1911		falls within 3 league limit	None
Gloria Colita	Schooner	1939	1941	1945	falls within 3 league limit	None
Margate	Cargo		1945	1945	falls within 3 league limit	None
Jennie S. Butler	Schooner		1900		falls within 3 league limit	None
Laura R. Burnham	Bark		1883		falls within 3 league limit	None
Patton	Barge	1910	1917		falls within 3 league limit	None
John S. Ames	Schooner		1899		falls within 3 league limit	None
Unknown	Tug		1944	1945	falls within 3 league limit	None
Besco	Unknown				falls within 3 league limit	None
S. C. 1063	Patrol Boat		1943	1943	falls within 3 league limit	None
Galveston	Dredge		1943	1950	falls within 3 league limit	None
ABL 92	Cargo		1943		falls within 3 league limit	None
Torry	Unknown		1878		North Padre Island, East Addition A-86	None
Orion	Cargo	1906	1945	1945	falls within 3 league limit	None
Unknown	Barge			1943	falls within 3 league limit	None
Oaxaca	Passenger/Cargo		1942	1943	falls within 3 league limit	None
U.S.S. Hatteras	Steamship		1863		Galveston 269	None

Central Gulf of Mexico

Of the geographic features listed in Table III-37 of the Final Regional EIS which have a high probability for associated prehistoric sites, all but karst areas are found in the Central Gulf.

The eastern portion of the CPA is characterized by Holocene deltaic deposits of the Mississippi River, ranging from several hundred feet thick to only a thin veneer. Subaerially developed natural levee ridges, delta front barrier islands, bays, and lagoons are abundant in this area. Sites around bays and lagoons would have a high probability for preservation, while natural levee sites may be preserved under the right conditions. Sites associated with relict delta front barrier islands would probably be extensively reworked and incorporated into the relict barrier island sands. The thickness of archaeologically sterile open-shelf Holocene marine sediments in some areas (generally closer to the active Mississippi Delta) may preclude recovery of site information in the underlying strata.

The western portion of the CPA is generally devoid of Holocene sediments, except in the extreme western portion where localized concentrations of transgressive Holocene sands reach thicknesses up to 7 m (USDI, MMS, 1984e). Many large, late Pleistocene fluvial systems are within a few feet of the seafloor in this area; an excellent example is provided by the ancient Sabine-Calcasieu River Valley. This ancient river valley was extensively studied and mapped by Nelson and Bray (1970) using borehole and seismic data. A study funded by MMS to locate prehistoric archaeological sites in association with the buried Sabine-Calcasieu River Valley has been completed recently. Five types of relict landforms, including valley margins/floodplains, terraces, natural levee ridges, point bars, and bay/estuary margins, were identified in association with this buried river valley. These landforms were further evaluated for potential archaeological deposits through the collection of original seismic data. Based on these data, vibracores were collected to evaluate areas of potential archaeological deposits. The final phase of this study attempted site identification through laboratory analysis of the core material. These sedimentary analyses suggest the presence of at least two archaeological sites at the locations tested (CEI, 1986). Lease block surveys from other areas have recorded evidence of numerous relict late Pleistocene fluvial systems ranging from a few hundred feet across with a maximum cut of 5-10 ft, up to several thousand feet across with maximum cuts of over 100 ft. Evidence of floodplains, terracing, and point bar deposits have been recorded in association with many of these fluvial systems. Sites located along floodplains and terraces, and within point bar deposits would be expected to have a higher potential for preservation than those sites located along the unprotected outer valley margins; however, these sites may also be preserved under the right conditions. Several examples of salt domes with bathymetric expression have also been recorded during lease block surveys in this area. Preservation of site materials associated with salt domes would be good within solution depressions and possibly in protected areas of rock outcrops associated with the salt dome. Due to the proximity of most of these relict landforms to the seafloor, the potential for further investigation and data recovery from these sites would be excellent.

Western Gulf of Mexico

Of the geographic features listed in Table III-37 of the Final Regional EIS which have a high probability for associated prehistoric sites, all but karst areas are found in the Western Gulf.

The western portion of the WPA is characterized by Holocene deltaic deposits of the Colorado and Brazos Rivers. According to a geologic map series produced by the MMS Office of Marine Geology at Corpus Christi, Texas, the Holocene sediments west of the 96°W longitude range from approximately 12-143 ft thick (Berryhill and Trippett, 1981). Data from lease block surveys in this area indicate that these Holocene sediments begin thinning east of the 96°W longitude. Subaerially developed natural levee ridges, delta front barrier islands, bays, lagoons, and salt domes with bathymetric expression have been recorded as a result of lease block surveys in this area. Sites around bays and lagoons would have a high probability for preservation, while natural levee sites may be preserved under the right conditions. Sites associated with relict delta front barrier islands would probably be extensively reworked and incorporated into the relict barrier island sands. Preservation of site materials associated with salt domes would be good within solution depressions and possibly in protected areas of rock outcrops associated with the salt dome. The thickness of archaeologically sterile open shelf Holocene marine sediments in some areas may preclude recovery of site information in the underlying strata.

The easternmost portion of the WPA is generally devoid of Holocene sediments except in areas of localized transgressive sand deposits. Many large, late Pleistocene fluvial systems are within a few feet of the seafloor in this area; an excellent example is provided by the ancient Sabine-Calcasieu River Valley. This ancient river valley was extensively studied and mapped by Nelson and Bray (1970) using borehole and seismic data. A study funded by

MMS to locate prehistoric archaeological sites in association with the buried Sabine-Calcasieu River Valley has been completed recently. Five types of relict landforms, including valley margins/floodplains, terraces, natural levee ridges, point bars, and bay/estuary margins, were identified in association with this buried river valley. These landforms were further evaluated for potential archaeological deposits through the collection of original seismic data. Based on these data, vibracores were collected to evaluate areas of potential archaeological deposits. The final phase of this study attempted site identification through laboratory analysis of the core material. These sedimentary analyses suggest the presence of at least two archaeological sites at the locations tested (CEI, 1986). Just north of the study area, along the east Texas coast, McFaddin Beach has produced late Pleistocene megafaunal remains and lithics from all archaeological periods. Work in this area has not presently allowed a definitive conclusion as to whether the site materials are eroding out of the beach deposits or are being washed onto the beach from offshore. Lease block surveys from other areas have recorded evidence of numerous relict late Pleistocene fluvial systems ranging from a few hundred feet across with a maximum cut of 5-10 ft, up to several thousand feet across with maximum cuts of over 100 ft. Evidence of floodplains, terraces, and point bars have been recorded in association with many of these fluvial systems. Sites located along floodplains and terraces, and within point bar deposits would be expected to have a higher potential for preservation than those sites located along the unprotected outer valley margins; however, these sites may also be preserved under the right conditions. Due to the proximity of most of these relict landforms to the seafloor, the potential for further investigation and data recovery from these sites would be excellent.

For a complete discussion of historic and prehistoric archaeological resources, see Volume 1, Section III.C.9. of the Final Regional EIS. Figure III-6 is a revised version of the sea level curve shown in Figure III-21 of the Final Regional EIS.

11. Water Supply

Water supply problems have arisen as the result of a great influx of population and industry into the Gulf coastal areas. Although much of the Central Gulf experiences little to no water supply problems due to its extensive water resources, several areas including the southern portion of Texas are presently experiencing shortages of both potable and nonpotable water sources. As a result of the extensive offshore oil and gas industry in the Gulf region, varying quantities of water are presently needed to assist this industry with its exploration and development activities in the Gulf of Mexico. Large quantities of freshwater, largely nonpotable, are transported offshore and used on rigs/platforms during drilling and workover activities. Table III-20 illustrates the locations of major service bases throughout the CPA and WPA. Other OCS support activities requiring large quantities of water include the refining of crude oil and gas processing. In 1983 alone, some 20 million bbls of crude oil and 0.83 tcf of gas were produced from Federal waters off Texas, requiring some 2.2 billion gallons of water for processing. In addition, some 291 million bbls of oil and 3.1 tcf of gas were produced off Louisiana and required some 20 billion gallons of water for processing. Table III-21 further describes the current freshwater withdrawals from all sources within the Central and Western Gulf coastal regions by county/parish. Table III-21 also estimates the capacities for gas processing and oil refining facilities within the Gulf coastal region and the potential water requirements for each. For these estimates, it can be assumed that an average of about 20% of the feedstock for coastal refineries and approximately 30% of gas processed comes from Gulf OCS production. These assumptions are averages with actual percentages for specific facilities varying from 0%-100%. The existing water supply of the coastal regions of the planning areas is briefly discussed below. For a more detailed discussion of water supply, see Volume 1, Section III.C.10. of the Final Regional EIS.

Central Gulf of Mexico

The Central Gulf abounds in surface and groundwater resources with plentiful supplies of fresh surface water due to the high rainfall rates and upstream runoff into the coastal basins. Rain surplus, coupled with favorable geologic conditions, has enabled extensive groundwater aquifers to develop throughout this region. Although plentiful water supplies abound here, continuous and cyclical groundwater pumpage takes place throughout the

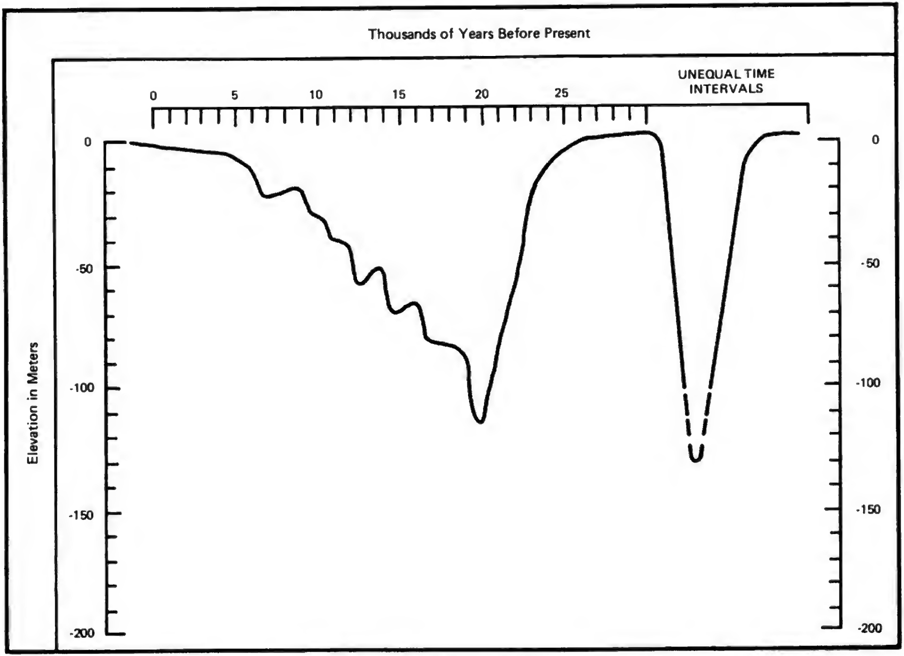


Figure III-6. Curve of Relative Land-Sea Level

Table III-20

Major Service Base Locations

Coastal Subarea

Texas

W-1 - Ingleside/Port Aransas/Harbor Island/Rockport
(Corpus Christi Area - Nueces, San Patricio, and Aransas Counties)
- Port O'Connor (Calhoun County)

W-2 - Freeport (Brazoria County)
- Galveston/Pelican Island (Galveston County)
- Sabine Pass (Jefferson County)

Louisiana

C-1 - Cameron (Cameron Parish)
- Grand Chenier (Cameron Parish)
- Intracoastal City (Vermilion Parish)

C-2 - Morgan City/Amelia (St. Mary Parish)

C-1 - Lafayette (Lafayette Parish)

C-2 - Houma (Terrebonne Parish)
- Dulac (Terrebonne Parish)
- Leeville (Lafourche Parish)
- Port Fourchon (Lafourche Parish)

C-3 - Grand Isle (Jefferson Parish)
- Venice (Plaquemines Parish)

Mississippi

C-4 - No major facilities at present

Alabama

C-4 - Mobile/Bayou LaBatre/Theodore (Mobile County)

Table III-21

Estimated Freshwater Withdrawals and Potential Water Use
in Gas Processing and Refining Activities
within the Gulf Coastal Counties/Parishes

Location	Freshwater Withdrawals All Sources (million gallons/day)	Gas Processing Capacity (million cfd)	Potential Water Use in Processing (million gallons/day)	Refining Capacity (bbls/day)	Potential Water Use in Refining (million gallons/day)
Alabama					
Baldwin	≤ 24	–	–	–	–
Mobile	≥ 500	110	0.165	89,400	4.72
Mississippi					
Harrison	25-99	–	–	–	–
Jackson	25-99	–	–	280,000	14.78
Louisiana					
Calcasieu	≥ 500	810	1.215	423,900	22.38
Cameron	25-99	2,481	3.722	–	–
Iberia	25-99	182	0.273	–	–
Jefferson	≥ 500	100	0.150	10,000	0.53
Lafourche	25-99	265	0.397	–	–
Orleans	≥ 500	–	–	–	–
Plaquemines	100-249	1,215	1.823	224,600	11.86
St. Bernard	≥ 500	3,365	5.047	206,500	10.90
St. Charles	≥ 500	960	1.440	288,600	15.24
St. Mary	100-249	4,302	6.453	–	–
St. Tammany	≤ 24	–	–	–	–
Terrebonne	≤ 24	2,195	3.293	10,780	0.57
Vermilion	≥ 500	3,220	4.830	7,500	0.39
Texas					
Aransas	≤ 24	85	0.128	–	–
Brazoria	100-249	132	0.198	408,000	21.54
Calhoun	≤ 24	227	0.340	–	–
Cameron	250-499	–	–	22,800	1.20
Chambers	100-249	635	0.952	–	–
Galveston	≤ 24	648	0.972	574,894	30.35
Harris	≥ 500	1,264	1.896	1,145,500	60.46
Jackson	25-99	–	–	–	–
Jefferson	100-249	756	1.134	1,312,800	68.64
Kenedy	≤ 24	200	0.300	–	–
Kleberg	≤ 24	2,700	4.050	–	–
Matagorda	100-249	335	0.502	–	–
Nueces	25-99	865	1.297	694,855	36.69
Orange	25-99	10	0.015	–	–
Refugio	≤ 24	234	0.351	–	–
San Patricio	≤ 24	400	0.600	–	–
Victoria	25-99	105	0.158	–	–
Wilacy	≤ 24	90	0.135	–	–

Central region, and in the last few decades declining water levels have reversed the direction of the hydraulic gradient in many areas aquifers, resulting in saltwater intrusion. Although there are numerous cases of saltwater intrusion throughout this region, surface water surpluses aid in maintaining the freshwater head necessary in preventing serious saltwater intrusion problems in the Central Gulf.

Although Louisiana has one of the most abundant supplies of ground and surface water in the United States, recent studies conducted by the State point to a growing awareness that economic growth and human activities both above and below the ground are degrading the quality of its water resources. These factors, coupled with the natural processes of erosion, subsidence, and the predicted sea level rise, currently threaten the future potential of these resources. In general, it was thought that the supplies of this area far exceeded the demands; however, as is the case with many of the coastal parishes, adequate water supplies do not always abound in those areas of need.

Many of the water supplies of the coastal communities near the fresh/saline interface are now and will continue to be affected by saltwater intrusion. Grand Isle, a barrier island resort community in southern Louisiana, is a prime example of this. This community is virtually isolated from any source of freshwater and at present imports some 500,000 gallons of freshwater per day from the Leeville, Louisiana, area some 12 miles west of Grand Isle. It is estimated that Grand Isle's water needs will double in the near future as a result of the increase in the area's population by summer recreationists. The demand on the water supply is so acute during the summer months that industries and visitors alike are rationed in their use of this precious commodity. Both surface and groundwater sources are either brackish or saline; therefore, the additional water needed will have to be obtained by importing water, desalinating water, or treating wastewater. Areas experiencing similar problems with saltwater intrusion consist of the City of Houma in Terrebonne Parish and all of the Plaquemines Parish area. These areas presently draw freshwater from two of the major sources of freshwater in the southern portion of the state; Houma from the Gulf Intracoastal Waterway and Plaquemines Parish from the Mississippi River. In both cases, the areas are in need of alternative sources of freshwater during periods of saltwater intrusion, some of which can persist up to 60 days in duration. In the Plaquemines Parish area, the parish has responded to the problem by storing water in tanks, interconnecting downstream systems with more upstream systems, diluting brackish water with freshwater from storage, and promoting water conversion. Despite the efforts of the parish to combat the effects of this saltwater intrusion problem, the problem seems to be worsening as a result of elevated rates of land loss within the area.

In contrast to the saltwater intrusion problem, many of the areas of the State are faced with the potential problem that their water supplies can be or are being polluted by industrial discharges from both point and nonpoint sources. This is the case with the River Parishes, which consist of St. James, St. John the Baptist, St. Charles, Jefferson, Orleans, St. Bernard, and Plaquemines Parishes. The primary source of municipal and industrial freshwater for these parishes is the Mississippi River. In this heavily industrialized reach of the river, more than 1.5 million people use about 214 million gallons of river water per day. A chemical or oil spill from a river vessel, industrial plant, pipeline, etc., is a constant danger. In the last 10 years alone, some 2,616 spills into the Missisippi River have been recorded by the Coast Guard. In the event the river was polluted and not usable, water users would have to either import alternative supplies or use water previously stored. For a 15-day emergency period alone, the River Parishes would require some 200 million gallons per day.

Continued non-OCS population and industrial growth in the coastal region is expected to significantly effect the level of water consumption throughout the potentially affected coastal area. In some areas, this new growth and development is likely to be substantial enough to require the modification/expansion of existing water supply and treatment facilities. In certain areas, the amount of economicaly available water resources will be a major constraint to new development.

Western Gulf of Mexico

The coastal segment of Texas depends heavily on its surface and groundwater resources for industrial, municipal, and agricultural uses. Rapid increases in urbanization and industrialization along the coastal area have drastically cut into its water supply. Present withdrawals in the Houston-Galveston area exceed the region's aquifer recharge capacity. Heavy pumpage of coastal aquifers has introduced problems concerning saltwater intrusion and subsidence in many of the coastal counties of the state. The pumpage of large quantities of groundwater in the Houston-Galveston region of Texas has resulted in declines in artesian pressure, further resulting in pronounced regional subsidence of the surrounding land surface. Several reports have described this subsidence as a result of the permanent compaction of fine-grained clay strata in the subsurface caused by loading due to pressure declines associated with the removal of subsurface fluids, primarily water, oil, and gas. As this phenomenon occurs, the overlaying land-surface tends to sink, resulting in lowering area elevations, changing surface gradients, and the activation of faults. The results are changes in drainage patterns, which aggravate flooding problems in the coastal areas and pose an increased risk of catastrophic flooding due to hurricane tidal surges. The greatest water supply problems exist in the lower Rio Grande Valley where the annual rainfall rates are less than 24 inches and surface water rights appear to be 100% appropriated. One of the remedies to the freshwater consumption needs of the Texas coastal zone has been the construction of several reservoir dams throughout the state; however, though these have aided in meeting the vast water consumption needs of the coastal zones, various side effects have added to existing water quality problems in these areas. Reduction of flow into estuarine systems aids in reduction of flushing and lengthens the time that pollutants remain in the bays and estuaries of the region.

The continued growth of non-OCS urban, industrial, and other development in the coastal region is expected to significantly effect (increase) the level of water consumption throughout much of the potentially affected coastal area. In some areas, this new development is likely to be substantial enough to require major modifications to, or expansion of, existing water supply and treatment facilities, the construction of new facilities, or the development of new sources. In certain areas, the availability of an adequate water supply has been, and will very likely continue to be, a major constraint to new development. A 1982 report by the Texas Department of Water Resources on "An Overview of Texas Water Resources Problems and Water Resource Issues" discusses current and future water resource problems in the State of Texas. This report shows conclusively the high cumulative impacts from population and non-OCS-related activities in the Texas coastal area.

Aquifers currently supply approximately 75% of the water used in Texas, and the water supplies of several of these major aquifers are slowly being depleted, with the rate of depletion being varied from area to area and depending upon the geologic hydrologic (water-bearing) characteristics of each aquifer, the quantity of natural recharge, and the rate of pumpage within each area. As groundwater levels decline and growth in water needs increases, the competition for remaining surface-water and groundwater resources will continue to increase, resulting in fewer and fewer options for adding new water supplies. In addition, under present practices of groundwater development and use, it is difficult to predict accurately the time of need and staging of reservoirs that will be needed to supply surface water to offset declining groundwater supplies. For example, neither local or state water planners have adequate information about future use of groundwater that can be depended upon in specific areas of the state in the future. Consequently, there has been a tendency to use past trends to predict future use of groundwater in an area. However, current knowledge indicates that the solution to land subsidence, saltwater encroachment, spring flow protection, and other considerations dictates that pumpage rates different from past trends of groundwater use are desirable and needed in some areas.

Water use statistics reported by industry and energy sectors show that water conservation measures are being developed and adopted in practically all of the manufacturing and energy sectors. It appears that two major factors underlie this phenomenon, rising energy costs and costs of treating and reclaiming industrial waste water. This trend is expected to continue for several years until the goals of Federal "clean water" legislation are reached and as long as energy costs continue to rise; hoever, there is a limit as to how much reduction in quantity of water used per unit of product can be achieved unless technology in production processes is improved. Growth in water use by industry is expected to continue as the site of the industrial base increases, i.e., as additional plants and new water using industries are located in Texas.

SECTION IV

ENVIRONMENTAL CONSEQUENCES

IV

IV. ENVIRONMENTAL CONSEQUENCES

A. DEVELOPMENT SCENARIOS

Development scenarios have been formulated to provide a quantitative and locational framework for detailed analysis of potential impacts of proposed OCS oil and gas lease sales in the Central and Western Planning Areas of the Gulf of Mexico (Figure IV-1).

Each development scenario is actually a hypothetical framework of assumptions and estimates on the amounts, timing, and general locations for OCS exploration, development, and production activities and facilities, both offshore and onshore which attempt to reasonably approximate potential activity conditions that would be associated with a sale. As such it is not a prediction of future oil and gas activities because all of these activities are unpredictable prior to a sale and only become clear as offshore and onshore development proceeds from lease through production. Such factors as the contemporary economic marketplace and available support facilities and pipeline capacities at the time of future infrastructure development are all unknowns. Notwithstanding these inherent difficulties, the scenarios represent best assumptions and estimates on a set of future conditions which are considered reasonably foreseeable and suitable for presale impact analyses.

It is noted that these development scenarios do not represent a MMS recommendation, preference, prediction, or endorsement of any level of leasing or offshore operations, or of the types, numbers, and/or locations of any onshore operations or facilities.

1. Proposed Actions: Most Likely Find Scenarios (M Scenarios)

The M Scenarios described in this section are for use in analyzing the impacts (sale specific) of the proposed actions. These scenarios are based on resource development estimates considered reasonably likely to occur as a result of the proposed actions. The resource estimates of oil and gas discovered and produced represent a fraction of the total undiscovered economically recoverable resources (mean conditional estimates) in each planning area. In addition, each of the scenarios was formulated on the basis of available data on recent levels of leasing and hydrocarbon discoveries, existing offshore and onshore oil/gas infrastructure, industry practice, and economic considerations. Table IV-1 provides a summary of major elements of the M Scenarios and some of the related impact producing factors for each proposed action.

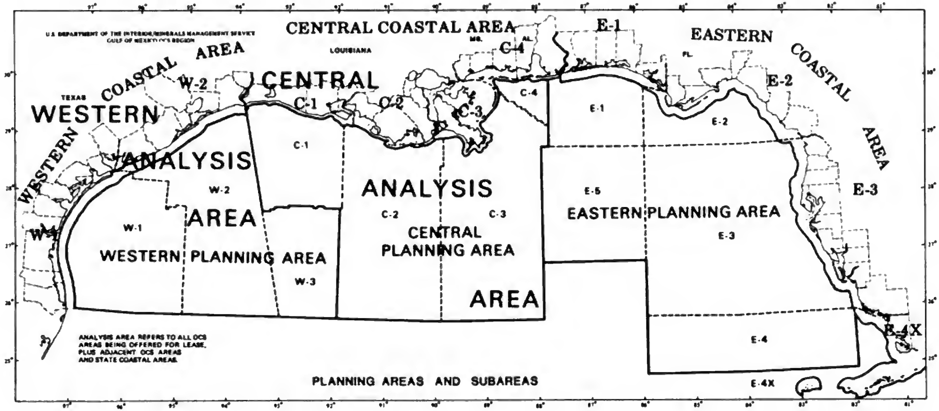
a. Resource and Offshore Infrastructure Estimates

Central Gulf Sale 110: This proposed action is to offer for lease all unleased blocks in the CPA. As of October 1985, there were 5,821 unleased blocks containing approximately 31.4 million acres in the CPA. The actual number of blocks offered for lease will differ from the October 1985 figure by an amount equal to the number of blocks relinquished, cancelled, and terminated, less the number of blocks leased (proposed Central Gulf Sale 104) during the intervening period.

The estimated amounts of oil and gas resources expected to be developed, as well as the total number of exploration and delineation wells, production platforms, development wells, and miles of offshore pipeline needed to discover, develop, and produce the estimated resources are included in Table IV-1.

The estimated amounts of oil and gas expected to be discovered and produced as a result of the proposed action are based on the mean estimates of the total undiscovered economically recoverable resources in the planning area (prepared by MMS using the resource assessment methodology described in USDI, MMS, 1985c), recent levels and trends in leasing, and estimates of resource recovery levels associated with recent sales. The estimated 0.260 billion bbls of oil and 2.150 trillion cubic feet (tcf) of gas expected to be discovered, developed, and produced as a result of Central Gulf Sale 110 represent about 14% of the mean conditional estimates of unleased undiscovered economically recoverable resources projected to exist prior to the proposed action. In the CPA the mean conditional estimates are equivalent to the risked estimated because the marginal probability that economically recoverable resources exist in the area is 1.00.

Western Gulf Sale 112: This proposed action is to offer for lease all unleased blocks in the WPA with the exception of two unique and highly sensitive blocks in the Flower Garden Banks (Blocks A-398 and A-375 in the High Island, East Addition, South Extension Area) and 123 blocks adjacent to the provisional United States maritime



U.S. DEPARTMENT OF THE INTERIOR/MINERALS MANAGEMENT SERVICE
GULF OF MEXICO OCS REGION

ANALYSIS AREA REFERS TO ALL OCS
AREAS BEING OFFERED FOR LEASE,
PLUS ADJACENT OCS AREAS
AND STATE COASTAL AREAS.

PLANNING AREAS AND SUBAREAS

Figure IV-1

Table IV-1

Summary - Major Elements of the M Scenario and
Related Impact Producing Factors for the Proposed Actions

	Central Gulf Sale 110	Western Gulf Sale 112
Resources Expected to be Developed[1]		
Oil (billion bbls)	0.260	0.130
Gas (tcf)	2.150	1.870
Peak Annual Production[2]		
Oil	0.023	0.012
Gas	0.194	0.168
Offshore Infrastructure		
Exploration and Delineation Wells Drilled	320	216
Production Platforms Installed	34	23
Development Wells Drilled	408	276
Pipeline (miles constructed)[3]	200	250
Transportation Assumptions		
Oil - Pipelined (billion bbls/%)	0.208/80	0.091/70
Oil - Shuttle Tankered (billion bbls/%)	0.052/20	0.039/30
Gas - Pipelined (tcf/%)	2.150/100	1.870/100
Offshore Discharges[4]		
Drilling Mud Material (million bbls)	3.30	2.24
Drill Cuttings (million cubic yards)	0.37	0.25
Formation Waters (billion bbls)	0.003 - 0.23	0.001 - 0.12
Offshore Air Emissions (peak year - 1,000 tons)		
NO_x	1.93	1.44
CO	0.33	0.25
SO_x	0.22	0.16
VOC	0.06	0.05
TSP	0.01	0.01
New Onshore Facilities[5]		
Service Bases (number/acres)	1/25	2/50
Pipeline Landfalls (number)	3	2
Pipeline (miles constructed/acres)	60/720	40/480
Shuttle Tanker Traffic (20,000 dwt/50,000 dwt)[6]	46/18	35/14
Service Vessel Traffic[6]	8,900	2,900
Helicopter Traffic[6]	21,000	13,500
Oil Spill Estimates: Occurrences/Probability of Occurrence/Probability of Contact[7]		
Large Spills (⩾1,000 bbls)	1/47/27	1/27/14
Medium Spills (50-999 bbls)	4/97/80	2/82/59
Small Spills (1-49 bbls)	99/99+/99+	50/99+/99+

[1] Estimates of oil and gas expected to be discovered and produced as a result of the proposed actions.

[2] Both oil and gas production are expected to occur over the 22-year period, 1989-2010. Peak oil production would occur from 1995 through 1997, and peak gas production would occur from 1998 through 2000.

[3] Gathering and main pipelines.

[4] Total amount. Section IV.A.4.a. contains a detailed discussion on these discharges.

[5] The maximum number of new facilities expected to be established solely as a result of the proposed action, and the maximum amount of acreage expected to be used for these facilities. See Tables IV-4 and IV-5 for location by coastal subareas.

[6] Number of trips (outbound plus inbound) for peak year activity.

[7] The assumed number of spill occurrences; the probability (expressed as percent chance) of one or more spills occurring; and the probability (expressed as percent chance) of one or more spills occurring and contacting land within 10 days. Spills are assumed to occur during the 22-year production period (1989-2010). The average size of a large spill is estimated at about 17 thousand bbls; the average medium spill is estimated at 154 bbls; and the average small spill is estimated at 4.2 bbls.

Source: USDI, Minerals Management Service, Gulf of Mexico OCS Region.

boundary with Mexico which have been deferred. As of December 1985, there were 4,918 unleased blocks containing approximately 27.3 million acres in the WPA (excluding the 125 deferred blocks). The actual number of blocks offered for lease will differ from the December 1985 figure by an amount equal to the number of blocks relinquished, cancelled, and terminated, less the number of blocks leased (proposed Western Gulf Sale 112) during the intervening period.

The estimated amounts of oil and gas resources expected to be developed, as well as the total number of exploration and delineation wells, production platforms, development wells, and miles of offshore pipeline needed to discover, develop, and produce the estimated resources are included in Table IV-1.

The estimated amounts of oil and gas expected to be discovered and produced as a result of the proposed action are based on the mean estimates of the total undiscovered economically recoverable resources in the planning area (proposed by MMS using the resource assessment methodology described in USDI, MMS 1985c), recent levels and trends in leasing, and estimates of resource recovery levels associated with recent sales. The estimated 0.130 billion bbls of oil and 1.870 tcf of gas expected to be discovered, developed, and produced as a result of Western Gulf Sale 112 represent about 10% of the mean conditional estimates of unleased undiscovered economically recoverable resources projected to exist prior to the proposed action. In the WPA the mean conditional estimates are equivalent to the risked estimates because the marginal probability that economically recoverable resources exist in the area is 1.00.

b. Development Timetables

The estimated development timetable for offshore infrastructure and the production schedule for each sale are shown in Tables IV-2 and IV-3.

Central Gulf Sale 110: Exploratory activity takes place over an 11-year period (1988-1998), with the most intense level of activity occurring from 1991-1992; development activity begins in 1989 with the installation of the first production platform and ends in 2000 with the drilling of the last 20 development wells; and production of oil and gas takes place over the 22-year period, 1989-2010. For additional data see Table IV-2.

Western Gulf Sale 112: Exploratory activity occurs from 1988-1998; development and production activity begins in 1989 with development activities being completed in 2000 and production activity extending through 2010 (22 years). For additional data see Table IV-3.

c. Transportation Assumptions

Central Gulf Sale 110: It is assumed that all gas production and at least 80% of the oil production will be transported by pipeline to onshore processing facilities in Louisiana, Mississippi, and possibly Texas. An additional 200 miles of offshore pipeline (including up to 100 miles of main lines with up to three landfalls) will move oil/gas production from production sites to either the existing offshore pipeline network or directly to onshore destinations. The extensive existing pipeline network (Visual No. 7) is estimated to be capable of handling most production resulting from the proposed action and that most major additions to the existing system will be made on the basis of new production resulting from several sales rather than a single sale.

The recent trend to a much higher level of leasing, exploration, and potential development activity in deepwater blocks (those with an average water depth of more than 200 m) not located in proximity to the existing oil transmission system is making shuttle tankering a feasible alternative to pipelining in some cases. Based on these trends, the following assumptions on the use of shuttle tankers are considered in the impact analyses: up to 20% (52 million bbls) of the total oil production will be transported to shore by shuttle tankers over a period of up to 22 years; oil transported will be from production facilities (which are likely to include floating production, storage, offloading, and single point mooring systems) in deepwater locations (in most cases exceeding 400 m) in subplanning areas C-2 and C-3; onshore destinations are assumed to be port offloading facilities in the New Orleans to Baton Rouge Mississippi River corridor; between 154 (using 50,000 dwt tankers) and 384 (using 20,000 dwt tankers) trips would be made; and the peak year number of trips would be between 18 (using 50,000 dwt tankers) and 46 (using 20,000 dwt tankers).

Western Gulf Sale 112: It is assumed that all gas production and at least 70% of the oil production will be transported by pipeline to onshore processing facilities in Texas and Louisiana. An additional 250 miles of pipeline (including up to 120 miles of main line and up to two landfalls) will move oil/gas production from production sites to either the existing offshore pipeline network or directly to onshore destinations. It is noted that the extensive existing pipeline network (Visual No. 7) is estimated to be capable of handling most production resulting from the proposed action and that most major additions to the existing system will be made on the basis of new production resulting from several sales rather than a single sale.

The recent trend to a much higher level of leasing, exploration, and potential development activity in deepwater blocks not located in proximity to the existing oil transmission system is making shuttle tankering a feasible alternative to pipelining in some cases. Based on these trends, the following assumptions on the use of shuttle tankers are considered in the impact analyses: up to 30% (39 million bbls) of the total oil production will be transported to shore by shuttle tankers over a period of up to 22 years; oil transported will be from production facilities (which could include floating production, storage, offloading, and single point mooring systems) in deepwater locations (in most cases exceeding 400 m) in subplaning areas W-1, W-2, and W-3; onshore destinations are assumed to be port offloading facilities in the Corpus Christi, Freeport, Galveston, Texas City, Port Arthur, and Beaumont areas of Texas, as well as the Lake Charles area in Louisiana; between 119 (using 50,000 dwt tankers) and 296 (using 20,000 dwt tankers) trips would be made; and the peak year number of trips would be between 14 (using 50,000 dwt tankers) and 35 (using 20,000 dwt tankers).

d. Onshore Facility Use Estimates

Central Gulf Sale 110: Offshore drilling and production operations resulting from Sale 110 are estimated to be supported from facilities located in Louisiana, Mississippi, Alabama, and Texas. Table IV-4 shows the major types and total numbers of existing and new support facilities estimated to be used in conjunction with offshore drilling and production, as well as their likely distribution by coastal subarea. The construction of possibly one new service base for drilling/production operations is estimated in coastal subarea C-4. The amount of land used for this new service base is estimated at 5-25 acres. Likely potential locations with available sites for a new service base include Harrison County (Long Beach-Biloxi area) and Jackson County (Pascagoula area) in Mississippi, and Mobile County (Mobile-Bayou LaBatre area) in Alabama. In addition, up to three new transmission pipeline landfalls with up to 60 miles of onshore routing are estimated; with possibly one landfall in each of coastal subareas C-1, C-2, and C-3. The amount of land used for each mile of onshore pipeline routing is estimated at 3-12 acres. All other onshore support activities are estimated to be readily provided from existing locations in the Central and Western coastal areas. Likely potential locations for the new pipeline landfalls include Cameron, Vermilion, Iberia, St. Mary, Terrebonne, Lafourche, Jefferson, Plaquemines, and St. Bernard Parishes (for analysis purposes not more than one pipeline landfall is assumed for any of these parishes).

Western Gulf Sale 112: Offshore drilling and production operations resulting from Sale 112 are estimated to be supported from facilities located in Texas and Louisiana coastal areas. Table IV-5 provides data on the major types and total number of existing and new facilities estimated to be used in support of exploration, development, and production operations, and their expected distribution by coastal subsection. The construction of up to two new service bases for drilling/production operations is estimated. The amount of land used for this new service base is estimated at 5-25 acres. Likely potential locations with available sites for a service base in coastal subareas W-1 and W-2 include the Port Isabel area (Cameron County, Texas), the Port Mansfield area (Willacy County, Texas), the Ingleside/Port Aransas/Rockport area (San Patricio, Nueces and Aransas Counties, Texas), the Port O'Connor area (Calhoun County, Texas), the Freeport area (Brazoria County, Texas) and the Galveston/Pelican Island area (Galveston County, Texas). New production could result in the construction of up to two pipelines with landfalls in coastal subarea W-1 and coastal subarea W-2. The amount of land used for each mile of onshore pipeline routing is estimated at 3-12 acres. Potential locations for a new pipeline landfall include each of the coastal counties located in coastal subareas W-1 and W-2.

2. Cumulative Activities (Cumulative Scenarios for the Proposed Actions)

The cumulative scenarios support impact analyses which consider the aggregate future impacts to existing conditions that are estimated to occur as a result of the proposed actions (under the M Scenario), prior OCS sales, future OCS sales included in the proposed 5-year OCS Lease Schedule (1987-1991), and major non-OCS activities that are pertinent. The cumulative impact analyses focus discussion on expected future impacts to existing environmental conditions. Impacts that have already occurred, or that are estimated to occur prior to the proposed actions (e.g., the impacts associated with past oil spill contacts, platform installation, pipeline construction, and

Table IV-2

Estimated Development Timetable for Offshore Infrastructure: Central Gulf Sale 110

Year	Exploration and Delineation Wells Drilled	Platforms Installed	Development Wells Drilled	Pipeline Emplaced (miles)	Oil Production (million bbls)	Gas Production (bcf)
1987						
1988	10					
1989	20	1	10	3	0.5	4.3
1990	35	2	20	6	0.8	6.5
1991	75	3	40	9	2.6	10.7
1992	70	4	60	12	13.0	21.5
1993	40	5	60	64	15.6	43.0
1994	25	5	60	15	18.2	64.5
1995	20	5	40	15	23.4	86.0
1996	11	4	30	12	23.4	129.0
1997	11	2	28	6	23.4	150.5
1998	3	2	20	55	22.1	193.5
1999		1	20	3	19.5	193.5
2000			20		18.7	193.5
2001					17.7	172.0
2002					15.6	154.8
2003					13.0	146.2
2004					9.1	133.3
2005					6.5	124.7
2006					5.7	107.5
2007					4.7	86.0
2008					3.1	64.5
2009					2.1	43.0
2010					1.3	21.5
Total	320	34	408	200	260	2,150

Source: USDI, Minerals Management Service, Gulf of Mexico OCS Region estimates.

Table IV-3

Estimated Development Timetable for Offshore Infrastructure: Western Gulf Sale 112

Year	Exploration and Delineation Wells Drilled	Platforms Installed	Development Wells Drilled	Pipeline Emplaced (miles)	Oil Production (million bbls)	Gas Production (bcf)
1987						
1988	7					
1989	14	1	10	6	0.3	3.7
1990	26	1	15	6	0.4	5.6
1991	48	2	20	12	1.3	9.4
1992	40	3	35	18	6.5	18.7
1993	32	4	50	80	7.8	37.4
1994	23	4	35	24	9.1	56.1
1995	14	3	35	18	11.7	74.8
1996	7	2	20	12	11.7	112.2
1997	3	1	15	6	11.7	130.9
1998	2	1	15	62	11.0	168.3
1999		1	15	6	9.8	168.3
2000			11		9.4	168.3
2001					8.8	149.6
2002					7.8	134.6
2003					6.5	127.2
2004					4.5	115.9
2005					3.2	108.5
2006					2.9	93.5
2007					2.3	74.8
2008					1.6	56.1
2009					1.0	37.4
2010					0.7	18.7
Total	216	23	276	250	130	1,870

Source: USDI, Minerals Management Service, Gulf of Mexico OCS Region estimates.

Table IV-4

Onshore Facility Use Assumptions: Central Gulf Sale 110

Facility	Total Existing	Total New	Coastal Subarea C-1 Existing	Coastal Subarea C-1 New	Coastal Subarea C-2 Existing	Coastal Subarea C-2 New	Coastal Subarea C-3 Existing	Coastal Subarea C-3 New	Coastal Subarea C-4 Existing	Coastal Subarea C-4 New	Coastal Subarea W-1/W-2 Existing	Coastal Subarea W-1/W-2 New
	Estimated Number of Existing and New Facilities Used for the Proposed Action											
Service Base	22	1	6	0	8	0	3	0	3	1	2	0
Pipeline Installation Base	5	0	1	0	1	0	1	0	1	0	1	0
Pipe Coating Yard	5	0	1	0	1	0	1	0	1	0	1	0
Pipeline Landfall	10	3	3	1	3	1	3	1	1	0	0	0
Miles Onshore Pipeline	85	60	30	20	30	20	15	20	10	0	0	0
Marine Terminal	2	0	0	0	0	0	2	0	0	0	0	0
Platform Fabrication Yard	6	0	1	0	1	0	3	0	1	0	1	0
Gas Processing Plant	8	0	2	0	2	0	2	0	1	0	1	0
Refinery	7	0	1	0	2	0	2	0	1	0	1	0

Note: The minimum number of existing facilities assumed to be used in support of the proposed action is listed. The estimated number of new facilities listed in the table indicates the maximum number expected to be established solely as a result of the proposed action.

Source: USDI, Minerals Management Service, Gulf of Mexico OCS Region estimates.

Table IV-5

Onshore Facility Use Assumptions: Western Gulf Sale 112

Estimated Number of Existing and New Facilities Used for the Proposed Action

Facility	Total Existing	Total New	Coastal Subarea W-1 Existing	Coastal Subarea W-1 New	Coastal Subarea W-2 Existing	Coastal Subarea W-2 New	Coastal Subarea C-1/C-2 Existing	Coastal Subarea C-1/C-2 New
Service Base	16	2	7	1	6	1	3	0
Pipeline Installation Base	3	0	1	0	1	0	1	0
Pipe Coating Yard	3	0	1	0	1	0	1	0
Pipeline Landfall	7	2	2	1	2	1	3	0
Miles Onshore Pipeline	70	40	20	20	20	20	30	0
Marine Terminal	5	0	1	0	3	0	1	0
Platform Fabrication Yard	7	0	2	0	2	0	3	0
Gas Processing Plant	6	0	2	0	2	0	2	0
Refinery	4	0	1	0	2	0	1	0

Note: The minimum number of existing facilities assumed to be used in support of the proposed action is listed. The estimated number of new facilities listed in the table indicates the maximum number expected to be established solely as a result of the proposed action.

Source: USDI, Minerals Management Service, Gulf of Mexico OCS Region estimates.

support facility construction), are not added to the future impacts; however, these impacts are allowed to the extent that they have affected existing environmental conditions and problems. Impacts related to the continued use and maintenance of existing (in place prior to the proposed sale) infrastructure, such as production platforms, onshore support and processing facilities, access waterways and pipelines, are considered in the cumulative analyses where they might be an important factor. Table IV-6 presents a summary of the major elements in the cumulative scenarios for the proposed actions. There are a number of other components of the cumulative scenario (not included in the summary table) that are discussed in the following sections and considered in the impact analyses.

a. Cumulative Scenario Factors Related to the Proposed Actions and to Prior and Future OCS Lease Sales

(1) Estimated Future Offshore and Onshore Infrastructure and Production from the Proposed Actions, Prior and Future OCS Sales

Table IV-6 includes the estimated future (occurring subsequent to the proposed actions) amounts of resources expected to be developed, aggregate oil and gas production, new offshore and onshore infrastructure, transportation assumptions, and other impact producing factors related to the proposed action, prior OCS sales, and future OCS sales included in the proposed 5-Year OCS Lease Schedule (1987-1991) in each planning area.

The major types and numbers of existing and new onshore facilities estimated to be used in support of offshore development in the CPA including their distribution by coastal subarea, are shown in Table IV-7. Likely potential locations for new facilities in coastal subarea C-1 include Cameron, Vermilion, and Iberia Parishes, except that a pipeline landfall is not estimated for Iberia Parish. Likely potential locations for new facilities in coastal subarea C-2 include St. Mary, Terrebonne, and Lafourche Parishes. Likely potential locations for new facilities in coastal subarea C-3 include Jefferson, Plaquemines, and St. Bernard (pipeline landfall only) Parishes. Likely potential locations for new facilities in coastal subarea C-4 include Jackson County, Mississippi, and Mobile County, Alabama. The amount of land used for each type of new facility is listed in the tabulation which follows.

Table IV-8 shows the major types and numbers of existing and new facilities estimated to be used in support of offshore drilling and production operations in the WPA including their distribution by coastal subarea. Likely potential locations for new facilities in coastal subarea W-1 include Cameron, Willacy, Kenedy (a possible pipeline landfall and a possible gas processing plant only), Nueces, San Patricio, Aransas, and Calhoun Counties. Likely potential locations for new facilities in coastal subarea W-2 include Brazoria, Galveston, Jefferson, and Matagorda Counties, except that no service bases are estimated for Matagorda County. Likely potential locations for a possible new facility in coastal subarea C-1/C-2 include Cameron and Vermilion Parishes. The amount of land used for each type of new facility is listed in the tabulation which follows.

Land Use Assumptions: The amount of land estimated to be used for new onshore facilities is based on the following assumptions:

Land Use Assumptions for New Facilities

Facility Type	Acres per Facility
Service Base	5-25
Pipeline Installation Base	5
Pipe Coating Yard	30-60
Onshore Pipeline (per mile)	3-12
Platform Fabrication Yard	20-400
Gas Processing Plant	40-60

(2) Existing Infrastructure

Table IV-6 includes data on existing OCS offshore structures (multiwell platforms, single well, and other structures), and miles of pipeline constructed in the Central and Western Gulf. Visual No. 7 shows the location of the multiwell platforms and major oil and gas pipelines; also shown and tabulated are the major onshore oil and gas

Table IV-6

Cumulative Scenario: Summary of Major Elements

	Central Gulf Sale 110	Western Gulf Sale 112
A. Related to Federal OCS Activity		
Resources Expected to be Developed[1]		
Oil (billion bbls)	2.024	0.807
Gas (tcf)	17.226	13.135
Aggregate Production[2]		
Oil (billion bbls)	6.204	1.107
Gas (tcf)	57.126	21.335
Offshore Infrastructure		
Existing (in place)		
Platforms[3]	2,800	256
Pipeline (miles)[4]	13,466	1,598
Additional[5]		
Exploration and Delineation Wells Drilled	2,554	1,435
Production Platforms Installed	273	153
Development Wells Drilled	3,271	1,836
Pipeline (miles constructed)[6]	1,350	1,480
Transportation Assumptions		
Oil Pipelined (billion bbls)	5.675	0.830
Oil Tankered (billion bbls)	0.529	0.277
Gas Pipelined (tcf)	57.126	21.335
Offshore Discharges[7]		
Drilling Mud Material (million bbls)	26.50	14.88
Drill Cuttings (million cubic yards)	2.98	1.67
Formation Water (billion bbls)	0.06 - 5.58	0.01 - 1.0
Offshore Air Emissions (thousand tons)[8]		
Nitrogen Oxides (NO_x)	225.9	55.8
Carbon Monoxide (CO)	45.9	9.3
Sulfur Oxides (SO_x)	42.7	7.4
Volatile Organic Compounds (VOC)	6.9	1.7
Total Suspended Particulates (TSP)	0.4	0.1
Transportation Activity[9]		
Shuttle Tanker Traffic (50,000 dwt/20,000 dwt)	100/250	52/180
Service Vessel Traffic (1,000 trips)	201	66
Helicopter Traffic (1,000 trips)	1,551	201
New Onshore Facilities[10]		
Service Bases (number/acres used)	10/250	5/125
Pipeline Installation Bases (number/acres used)	1/5	2/10
Pipe Coating Yards (number/acres used)	1/60	2/120
Pipeline Landfalls (number)	14	10
Onshore Pipeline (miles/acres used)	280/3,360	200/2,400
Platform Fabrication Yards (number/acres used)	3/1,200	2/800
Gas Processing Plants (number/acres used)	4/240	2/120
B. State Offshore Oil and Gas Activity		
Platforms[11]	800	200
Pipelines (number/miles)[12]	120/1,200	31/320
Production (annual)[13]		
Oil (billion bbls)	0.0243	0.0023
Gas (tcf)	0.316	0.148
C. Oil Spill Estimates: Occurrences/Probability of Occurrence/Contacts/Probability of Contact[14, 15, 16, 17, 18]		
Large Spills (≥1,000 bbls)	45/99+/12/99+	45/99+/4/96
Federal OCS Gulf of Mexico Activity	19/99+/10/99+	19/99+/3/89
State Offshore Activity	1/65/1/59	1/65/1/18
Imports by Tanker	25/99+/2/83	25/99+/1/58
Medium Spills (50-999 bbls)[19]	103/99+/52/99+	103/99+/13/99+
Federal OCS Gulf of Mexico Activity	98/99+/48/99+	98/99+/12/99+
State Offshore Activity	6/99+/4/98	6/99+/1/63
Small Spills (1-49 bbls)[19]	2,992/99+/1,483/99+	2,992/99+/360/99+
Federal OCS Gulf of Mexico Activity	2,837/99+/1,381/99+	2,837/99+/335/99+
State Offshore Activity	156/99+/102/99+	156/99+/26/99+

Table IV-6. Cumulative Scenario: Summary of Major Elements (continued)

[1] Resources estimated to be discovered and developed subsequent to the proposed action. These resources are the result of the proposed action under the M Scenario, prior OCS sales in the planning area (estimated undiscovered leased resources as of the date of the proposed action), and future OCS sales in the planning area included in the proposed 5-year OCS lease schedule, 1987-1991 (M Scenario estimates).

[2] Aggregate resources estimated to be produced subsequent to the date of the proposed action (over the 28-year period, 1987-2014). These resources include "Resources Expected to be Developed" (footnote 1) plus the projected reserves related to prior OCS sales in the planning area as of the date of the proposed action.

[3] Multiwell, single well, and other structure types as of 12/31/83.

[4] As of 12/84, includes State-permitted pipelines originating in Federal OCS waters.

[5] Related to resources expected to be developed; added subsequent to the date of the proposed action.

[6] Gathering and main lines.

[7] Total discharges related to exploration and development activity.

[8] Total amounts related to exploration, development, and production activity. Occurring over the 28-year period, 1987-2014.

[9] Number of trips (outbound plus inbound) for peak year activity. Shuttle tanker traffic related to the exclusive use of 20,000 dwt and 50,000 dwt tankers is indicated. It is probable that a mix of tankers with different capacities will be used so that actual peak year traffic would fall somewhere between the low and high figures listed.

[10] Maximum number of new facilities expected to be established, and the maximum amount of acreage expected to be used for the listed facilities. See Table IV-7 (CPA) and Table IV-8 (WPA) for location by coastal subarea.

[11] Single well, multiwell, and other structure types as of 12/31/83.

[12] Estimates as of 1981.

[13] For 1983.

[14] Resulting from both proposed actions, prior OCS sales and future OCS sales (included in the proposed 5-year OCS lease schedule, 1987-1991) in the Gulf of Mexico, plus crude oil imports by tanker in the Gulf (large spills only), and continued oil production in State offshore waters over the period 1987-2014.

[15] Listed are the assumed number of oil spill occurrences (the assumed number is equal to the estimated mean number rounded up to the next whole number); the probability (percent chance) of one or more oil spills occurring; the estimated number, for analysis purposes, of oil spills occurring and contacting land in the potentially affected coastal area (footnote 16) within 10 days (the estimated number is derived by rounding the calculated mean number of spill contacts to the next whole number); and the probability (percent chance) of one or more oil spills occurring and contacting land in the potentially affected coastal area (footnote 16) within 10 days.

[16] The potentially affected coastal area for spills resulting from oil/gas development in the CPA is comprised of land segments 10 (Galveston/Chambers Counties, Texas) through 23 (Baldwin County, Alabama); similarly, the potentially affected coastal area for the WPA is comprised of land segments 1 (Cameron County, Texas) through 12 (Cameron Parish, Louisiana).

[17] Estimates of oil spill contacts for Federal OCS Gulf of Mexico activity and imports by tanker are based on the OSRA findings for large spills and on the assumption that the percent of small and medium spill occurrences which reach shore (contact land) will be the same as for large spills. Estimates of spill occurrences from State offshore oil and gas activity are based on the same spill rates used for OCS-related spills.

[18] Average large oil spill size is estimated at about 17 thousand bbls; the average medium oil spill is estimated at about 154 bbls; and the average small oil spill is estimated at about 4.2 bbls.

[19] Does not include spills related to imports by tanker.

Table IV-7

Cumulative Scenario: Onshore Facility Use Assumptions for the Proposed Action (Sale 110) and Prior and Future Sales in the Central Gulf Planning Area

	Estimated Number of Existing and New Facilities Used											
	Total		Coastal Subarea C-1		Coastal Subarea C-2		Coastal Subarea C-3		Coastal Subarea C-4		Coastal Subarea W-1/W-2	
Facility	Existing	New	Existing	New	Existing	New	Existing	New	Existing	New	Existing	New
Service Base	36	10	8	3	15	3	5	2	2	2	2	0
Pipeline Installation Base	7	1	2	0	2	0	2	0	1	1	1	0
Pipe Coating Yard	6	1	2	0	2	0	2	0	1	1	1	0
Pipeline Landfall	80	14	30	4	30	5	20	4	1	1	0	0
Miles Onshore Pipeline	710	280	300	80	300	100	100	80	10	20	0	0
Marine Terminal	4	0	0	0	1	0	3	0	0	0	0	0
Platform Fabrication Yard	11	3	3	1	3	2	1	0	1	0	3	0
Gas Processing Plant	15	4	4	1	4	1	4	1	2	1	1	0
Refinery	11	0	2	0	4	0	2	0	1	0	2	0

Note. The minimum number of existing facilities assumed to be used in support of aggregate OCS activity is listed.

Source: USDI, Minerals Management Service, Gulf of Mexico OCS Region estimates.

Table IV-8

Cumulative Scenario: Onshore Facility Use Assumptions for the Proposed Action (Sale 112) and Prior and Future Sales in the Western Gulf Planning Area

	Estimated Number of Existing and New Facilities Used							
	Total		Coastal Subarea W-1		Coastal Subarea W-2		Coastal Subarea C-1/C-2	
Facility	Existing	New	Existing	New	Existing	New	Existing	New
Service Base	28	5	11	3	9	2	8	0
Pipeline Installation Base	5	2	1	1	2	1	2	0
Pipe Coating Yard	5	2	1	1	2	1	2	0
Pipeline Landfall	10	10	3	5	4	5	3	0
Miles Onshore Pipeline	150	200	45	100	60	100	45	0
Marine Terminal	7	0	2	0	4	0	1	0
Platform Fabrication Yard	8	2	2	1	2	1	4	0
Gas Processing Plant	12	2	4	1	5	1	3	0
Refinery	7	0	2	0	4	0	1	0

Note: The minimum number of existing facilities assumed to be used in support of aggregate OCS activity is listed.

Source. USDI, Minerals Management Service, Gulf of Mexico OCS Region estimates.

support and processing infrastructure (not all of this infrastructure is used exclusively or in part for Federal offshore oil and gas activity).

Data on the annual and cumulative construction of oil and gas pipelines in or originating in the Federal OCS are shown in tables included in Final EIS 104/105 (Tables IV-13 and IV-14). These data indicate that approximately 90% of OCS pipeline segments and mileage are located in the Central Gulf of Mexico. Development in the Western Gulf of Mexico did not begin until 1965. Annual pipeline installations since 1970 have added between 300-1,300 miles (averaging 600 miles per year) to the existing network in Federal waters.

About 3% of the pipeline segments installed in the Federal OCS extend into State waters, where authorization is under State jurisdiction. MMS records indicate that 181 segments extend from the Federal OCS into State waters in the Central Gulf and 10 segments in the Western Gulf. Of the pipelines that were installed as a result of the Federal resource recovery program in the OCS, Gulf of Mexico, approximately 8% of the total mileage falls within State offshore waters. About 1,124 miles of pipelines in State waters are extensions of lines that originate in the Federal OCS; 1,004 miles of such lines are in Louisiana waters and 120 miles are in Texas waters. Of the pipelines that extend into State waters, some terminate at platforms and in subsea tie-ins with existing systems. Approximately 152 pipelines that originate in the Federal OCS extend through State waters and go ashore. Most of these (137) are in Louisiana, 2 are in Mississippi, and 13 are in Texas. During the 1970's, OCS pipeline landfall construction averaged 5.7 per year in the central coastal area and only 0.2 per year in the western coastal area. Since 1980 the average has dropped to 3.2 per year in the central coastal area and increased to 0.8 in the western coastal area.

b. State Offshore Oil/Gas Activities

Comprehensive information on oil and gas activities in State waters in the Gulf of Mexico region has not been compiled. In addition, many activities carried out prior to the 1950's were not documented or permitted in the way they are now and information is scarce or lacking (Groat, Personal communication, 1984).

The States of Texas and Louisiana have experienced offshore oil and gas exploration, development, and production ativities for over 30 years. The cumulative number of offshore wells (defined as those producing from beyond natural shorelines) drilled in State waters as of January 1, 1983, has been significant (American Petroleum Institute, 1984): Louisiana 3,981 wells; and Texas - 1,094 wells. The estimated number of offshore oil and gas structures (platforms and other structures) in Texas and Louisiana State waters as of December 31, 1983, are estimated at about 200 and 800, respectively (USDI, MMS, 1984f). Pipelines that are located entirely within State offshore waters, wetlands, and uplands do not require permits from MMS and an accurate data base for such lines is apparently not readily available. Estimates based on maps published by the Louisiana Geological Survey in 1981 and industry sources indicate that approximately 120 such pipelines, totaling 1,200 miles in length have been permitted within Louisiana's offshore waters, and 31 lines totaling approximately 320 miles have been permitted in Texas' waters. Of these, approximately 90 pipelines go ashore in Louisiana, 2 in Mississippi, and 24 in Texas. Approximately one-fifth of the pipelines that go ashore in Louisiana have multiple landfalls intersecting the coast at several locations.

In Texas offshore waters, accumulated oil and gas production to January 1, 1984, was 26.1 million bbls of oil and 2,877 billion cubic feet of gas. Annual oil production peaked in 1977 at 2.6 million bbls; by 1982 production was down to 1.8 million bbls; however, in 1983 production increased to 2.3 million bbls. Annual gas production peaked in 1980 at 254 billion cubic feet and by 1983 annual production had declined to 148 billion cubic feet. In Louisiana offshore waters, accumulated oil and gas production to January 1, 1984, was 1,338.4 million bbls and 9,654 billion cubic feet, respectively. Annual oil production peaked at 72.1 million bbls in 1970 and declined to 24.3 million bbls in 1983. Annual gas production reached a peak of 604 billion cubic feet in 1972, thereafter steadily declining to 316 billion cubic feet in 1983 (USDI, MMS, 1984f). For Louisiana, some information is available on leasing for the years 1960 to the present. The Louisiana Mineral Board, which was created in 1936, conducts lease sales monthly. Between 1962-1982, the State leased 800,779 acres offshore. Between January 1980 and August 1983, the State awarded 235 leases, which totalled 223,740 acres offshore.

The State of Mississippi has experienced a limited amount of offshore activity. Three exploratory wells were drilled in the 1950's. All were dry holes, and the relevant leases have expired. In 1982 the State held an offshore offering in which only one lease was granted. No exploration activity has yet occurred as a result of this lease. As a result of the success experienced in the Mobile Bay area (in Alabama State waters) 10 miles to the east of the State line, Mississippi offered the lower portion of Mississippi Sound for lease in January 1985. Several leases were granted as a result of the offering.

Oil and gas activity in the State of Alabama's offshore waters has become very active over the past few years. The lower Mobile Bay Mary Ann Field was discovered in 1979. This field has estimated reserves of as much as 600 billion cubic feet of natural gas. In 1981 and 1982 the State leased 33 blocks. By the end of 1984 about 14 wells had been drilled, and exploration activities by a number of companies continue. Since the initial discovery of 1979, several other discoveries have been made, confirming the commercial potential of natural gas in Mobile Bay. However, no production has yet taken place. Plans are now underway on a major processing plant (80 MM cfd) to treat gas from the field at a site about 20 miles south of Mobile.

c. Other Major Offshore Activities

(1) Marine Transportation and Tankering of Imported Crude Oil

The Gulf of Mexico is one of the busiest areas in the world for waterborne commerce. Projections indicate that traffic levels associated with all OCS exploration, development, and production plus all other marine transportation activities (declining in recent years, but assumed to remain constant at 1983 levels) will reach over 603,000 trips in the peak year of OCS-related activity (1991). This is an increase of about 44% over current traffic levels. Section III.C.6. includes a discussion of the latest COE statistics on all recorded vessel trips in the Central and Western Gulf.

Increases in marine transportation can contribute to operational errors which might result in groundings and in collisions involving other vessels or fixed structures such as platforms and rigs. This might lead to losses in lives, property, and possibly environmental damage if hazardous cargo is involved. Other problems associated with increased traffic include congestion in fairways and channels and increased demand for port and harbor space. The latter could be a positive factor at ports that can accommodate expansion, but could result in critical habitat losses if expansion takes place in sensitive areas such as wetlands.

The most significant contributions of marine transportation to cumulative impacts in the Gulf are from crude oil tankering. While most oil produced on the Gulf OCS is brought to shore via pipeline (less than 3% is estimated to be barged to shore), a large amount of crude oil from production areas outside the Gulf of Mexico Federal OCS region. Extensive refinery capacity, easy port access, and a well developed onshore transportation system have contributed to the development of the Gulf Coast region as an important center for handling imported oil and production from other domestic sources such as Alaska and California (henceforth included in the category of imports). The area also includes the Nation's Strategic Petroleum Reserve (Section I.B.6.j.) and LOOP, the only deepwater crude oil terminal in the country (Section I.B.6.b.).

The major Gulf Coast ports of entry for imported oil are listed on Table IV-9. Included are the amounts of crude oil estimated to be imported into Gulf ports during the 28-year period of 1987-2014. This is the period of exploration, development, and production for Sales 110, 112, and the remainder of the Gulf of Mexico OCS sales in the proposed 5-year schedule. The import projections are based on the disparity between expected domestic production and feed stock demands.

Figure IV-2 shows the general routes the tankers are expected to traverse and the locations of the major United States Gulf Coast ports of entry. The relative width of the tanker routes shown on the figure indicate the average annual level of projected fully laden (one way) tanker trips along those routes. The projected number of tanker trips are based on average dead weight tonnage (dwt) and projected imports.

Crude oil tankering can contribute to contamination of the marine environment in two ways: (a) Operational discharges occur when oily bilge water is pumped overboard and during tank cleaning and ballasting. Tankers' bilges must be periodically pumped out to remove oil and water collected in the lower part of the ship's hull from leaking pipes, valves, and machinery. Bilge water may first be put into a settling tank to separate the oil from the water. Some vessels pump bilge water through an oil-water separator which can significantly reduce the amount of oil discharged. (b) Oil is usually discharged during tank cleaning because some oil inevitably remains in the tanks after offloading. Also, ships that do not have segregated ballast tanks will take on seawater into "empty" oil tanks for use as ballast. When discharged, this water will contain the oil residue left in the tank.

United States and international regulations generally prohibit any operational discharges within 50 miles of land and require that no more than 15.8 gallons (60 litres) of oil be discharged per nautical mile. In addition, no vessel may discharge more than 1/15,000 of its dwt. About 3 million bbls of oil and water are expected to be discharged into the Gulf as a result of routine operations during the 28-year period.

Accidental spills normally result from collisions and groundings. Table IV-9 provides estimated numbers (mean) of offshore and in-port spills and the probability of one or more spill occurrence (expressed as percent

Table IV-9

Potential Impact Producing Factors Associated with Projected Crude Oil Imports[1] Offloaded at Gulf of Mexico Ports During the 28-Year Period of 1987-2014

	Volume Transported/ Offloaded (billion bbls)	Tanker Trips/ Port Calls[2]	Operational Discharges[3] (bbls)	Spill Occurrences/Probability[4]								Spills Occurring and Contacting Land[5]	
				≥1,000 bbls		≥10,000 bbls		1,000-10,000 bbls		≥100,000 bbls		≥1,000 bbls	
				no.	prob.	no.	prob.	no.	prob.	no.	prob.	no.	prob.
Offshore in the Gulf of Mexico	54.33	253,580	1,821,750	24.4	99+	13.5	99+	10.9	99+	5.2	99+	2.0	87
In Port:													
Mobile, AL	0.017	50		n	n	n	n	n	n	n	n	-	-
Pascagoula, MS	4.90	13,800		1.0	62	0.4	31	0.6	46	0.2	19	-	-
Miss. River Ports	14.65	41,270		2.9	95	1.1	67	1.8	84	0.6	46	-	-
LOOP	10.64	3,750		2.1	88	0.8	55	1.3	74	0.4	36	-	-
Morgan City, LA	0.14	790		n	n	n	n	n	n	n	n	-	-
Lake Charles, LA	3.05	8,590		0.6	46	0.2	20	0.4	32	0.1	12	-	-
Port Arthur, LA	2.35	6,620		0.5	37	0.2	16	0.3	75	0.1	9	-	-
Beaumont, TX	4.76	13,410		1.0	62	0.4	30	0.6	45	0.2	18	-	-
Galveston, TX	4.54	12,790		0.9	60	0.3	28	0.6	43	0.2	17	-	-
Texas City, TX	0.95	2,680		0.2	17	0.1	7	0.1	11	n	n	-	-
Freeport, TX	3.28	9,240		0.6	48	0.2	22	0.4	34	0.1	13	-	-
Corpus Christi, TX	4.90	13,800		1.0	62	0.4	31	0.6	46	0.2	19	-	-
Total in Port	54.33	126,790		10.9	99+	4.1	99+	6.8	99+	2.3	90	-	-

n = less than 0.04 occurrences or 0.4% chance.

[1] Estimates include domestic production transported from Alaska and California via tanker to Gulf of Mexico ports.

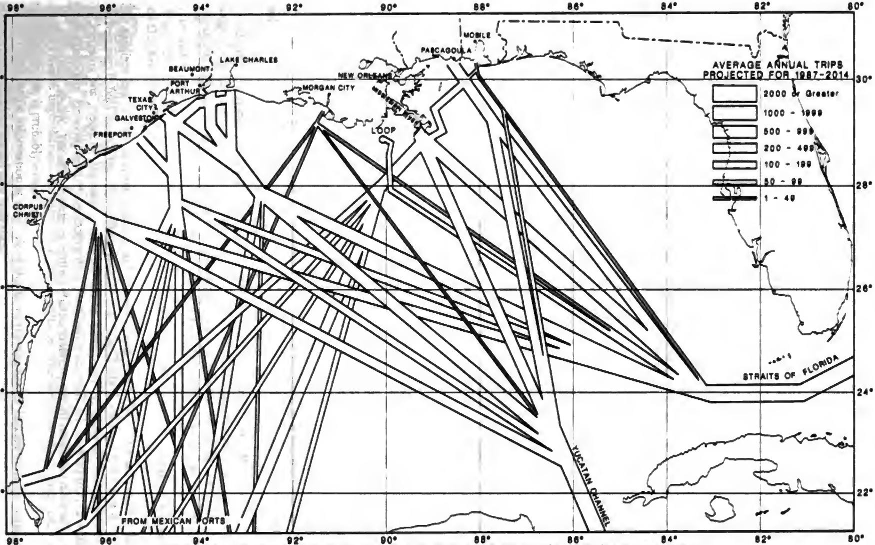
[2] Tanker trips are based on use of 50,000 dwt tankers for all ports except Morgan City and LOOP, which are based on 25,000 and 40,000 dwt tankers, respectively. The tanker trip total for offshore in the Gulf of Mexico is double the sum of all port calls to reflect trips to and from ports of call.

[3] The operational discharge quantity is based on regulations limiting the amount of tank cleaning water and oily ballast that can be discharged. Discharging within 50 miles of land is not permitted.

[4] The number (mean) of occurrences is equal to the volume of oil transported/offloaded at port (billion bbls) multiplied by the following spill rates (number of spills/billion bbls): ≥1,000 bbls - 0.45 and 0.20; ≥10,000 bbls - 0.25 and 0.075; 1,000-10,000 bbls - 0.20 and 0.125; and ≥100,000 bbls - 0.095 and 0.042. The first of the listed spill rates for each spill size category is for occurrences at sea and the second rate is for occurrences while transiting inland waters and at port. The probabilities listed are the percent chance of one or more spill occurrences. Oil spills greater than 1,000 bbls are considered to be governed by a Poisson process (Smith and others, 1982 and Lanfear and Amstutz, 1983). The probability of a specific number of spills (P(n)) occurring is described by the Poisson distribution: $P(n) = e^{-a}\, a^n/n!$, where n is the specific number of spills (0, 1, 2, . . ., n), e is the base of natural logarithms, and a is the mean of the Poisson distribution. The probability of one or more spills is calculated as $1 - P(0)$ or $1 - e^{-a}$, where a is the (mean) number of occurrences.

[5] Mean number of contacts and probability of one or more contacts (expressed as percent chance) within 10 days of occurrence, based on OSRA estimates. OSRA was not run for subcategories of ≥ 1,000 bbls (i.e., ≥ 10,000, 1,000-10,000, and ≥ 100,000). The OSRA does not estimate spills occurring and contacting land sensitive targets for inland water or ports. See text for a discussion of these spills.

[6] Mississippi River ports included are New Orleans, Baton Rouge, Grammercy, St. Rose, and Vicksburg.



CRUDE OIL TANKER ROUTES TO MAJOR U.S. PORTS OF ENTRY ON THE GULF OF MEXICO.

Figure IV-2

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chance) for several spill size categories that may result from the projected imports. Included are two offshore spills greater than 1,000 bbls that have an 87% probability of occurring and contacting land within 10 days (see OSRA, Section IV.B.1.). The OSRA does not provide estimates of the mean number and probabilities of one or more spills resulting from import tankers in inland water and during offloading operations in port. However, it is considered reasonable to assume that all such spills, if not immediately contained would contact port facilities or land. Most ports maintain spill containment and cleanup equipment (Section IV.B.4.) and are able to avoid damage from typical spills. The greatest inland spill threat arises in cases of unreported spills near sensitive habitats (i.e., in navigational channels through wetlands) or near intakes for drinking water.

(2) Ocean Dumping

There is one USEPA designated dump site in the Gulf of Mexico (Visual No. 11); it is designated for incineration of hazardous wastes, but there are no active permits for incineration at sea. This site is located in deepwater seaward of the continental shelf. See Section I.B.6.e. for a discussion of ocean dumping and Section I.B.6.f. for a discussion of ocean incineration.

(3) Military Use

Ten percent of the water and air space of the Central Gulf is used extensively but not intensively by the Navy, Naval Reserve, and Air National Guard for carrier flight qualifications, and pilot training. Thirty-seven percent of the water and air space of the Western Gulf is used by the Air Force and Navy for carrier flight qualifications, bombing runs, navigation exercises, and pilot training. Warning Area 228 is used intensively by the Navy within a radius of 150 miles of Corpus Christi and less beyond the 150-mile radius, and Warning Area 602 is used extensively but infrequently by the Air Force. All military warning areas and water test areas for the Gulf of Mexico are shown on Visual No. 11.

(4) Recreational Fishing

Saltwater fishing is a marine recreational activity that is growing in participation and economic significance throughout the inshore, nearshore, and offshore zones of the Gulf of Mexico region. Results from the National Marine Fisheries Service's (NMFS) Statistical Survey indicate that about four million saltwater fishermen in the Gulf region made about 20 million fishing trips during 1980. Fishing from boats is the most popular mode of marine recreational fishing in the Gulf region (over 50% of all fishing trips). In 1982 over 1.7 million motor boats, approximately one-fifth of the Nation's recreational boating fleet, were registered in the five states of the Gulf region. Over 700,000 of these motor boats are 16 feet or larger or potentially capable of navigating in the nearshore and offshore zones of the Gulf of Mexico.

The focus of most offshore fishing is around natural and artificial features where fish are likely to be located. Demand for artificial fishing reefs, especially in the Eastern Gulf, has increased in the last few years. Over 120 designated and permitted artificial fishing reefs composed of ships, barges, tires and concrete rubble have been placed in the Gulf of Mexico over the past 25 years. Increasing interest in the reuse of obsolete oil and gas structures for artificial reefs has led to a Gulfwide interest in a rigs-to-reefs program. To date six oil and gas structures have been converted to permanent fishery enhancement devices on dedicated reef sites.

(5) Commercial Fishing

NMFS landings data for 1977-1981 show approximately 1.68 billion pounds of finfish and shellfish with an annual dockside value of $429.8 million in the Central and Western Gulf. Important species landed commercially in the Gulf include shrimp, menhaden, blue crab, oyster, mackerels, drums, seatrouts, snappers, and groupers. There are approximately 27,336 commercial fishermen Gulfwide with processed fishing products amounting to about $515.3 million. The main processed fishery products include shrimp, menhaden, lobsters, oysters, and crabs.

(6) Deepwater Ports

The Louisiana Offshore Oil Port (LOOP) is the only deepwater port in the Gulf of Mexico. LOOP's function is to facilitate the offloading of oil from vessels too large to visit conventional Gulf ports (typically supertankers with drafts greater than 40 feet and up to 700,000 dwt) and to transport the oil to shore via pipeline. In 1983, LOOP offloaded 140.9 million bbls of crude oil from 168 tankers. No mobile drilling operations or installation of permanent structures may take place within LOOP's designated safety zone, fairway, or anchorage. For additional information, see Section I.B.6.b.

(7) Non-Energy Minerals Program in the Gulf of Mexico

The Non-Energy Minerals program in the Gulf of Mexico is currently inactive. Earlier planning had tentatively called for a construction materials lease sale for January 1986; however, this schedule is no longer in effect and no new tentative sale date is known.

d. Major Onshore Activities in Coastal Areas

(1) Oil and Gas Facilities

The central and western coastal portion of the Gulf Coast has one of the highest concentrations of oil and gas activities and related and service-support processing infrastructure in the world. This onshore activity and infrastructure includes: exploratory/development drilling and production well sites and access canals and roads to these sites; oil and gas pipelines; oil refineries; gas processing plants; petrochemical plants; pumping and compressor stations; pipe coating and storage yards; platform and rig fabricaton yards; service/support bases, including docking facilities; shipyards; service, repair, and maintenance service facilities; ports; and access channels to the Gulf. It is noted that with the exception of the exploratory/development/production well sites and related infrastructure, much of this onshore infrastructure is heavily used and, in some cases, is exclusively used (or owes its existence to) in support of offshore oil and gas activity, both in State and Federal waters. Visual No. 7 indicates the location of several major types of these facilities (supply or service bases, platform fabrication yards, pipe coating yards, shipyards, gas processing plants, oil refineries, selected ports, and oil and gas pipeline landfalls), both graphically and in tabular format. The tabular format on the back of the visual includes the company name, capacity, and location of all gas processing plants and refineries.

Comprehensive information on the extent of oil and gas activities in the coastal area of the Gulf of Mexico region has not been compiled. For many activities, particularly those prior to 1950, information is scarce or lacking. In Louisiana, virtually all privately-owned lands in the coastal area have been leased for oil and gas development. For Louisiana, there are approximately 34,200 wells in the coastal area (which includes the following parishes: Cameron, Iberia, Jefferson, Lafourche, Orleans, Plaquemines, St. Bernard, St. Charles, St. John the Baptist, St. Mary, Terrebonne, and Vermilion).

Access canals and pipelines to service onshore development are pervasive throughout the coastal area. Between 1978 and 1982, approximately 1,900 petroleum canals were dredged in coastal Louisiana to provide access to well sites. The typical dimensions of an oil and gas access canal, as indicated on permits, are as follows: a canal 1,200 feet long and 70 feet wide with a drill slip at the end measuring 345 by 160 feet. The cumulative linear extent of canals, including oil and gas access canals, in coastal Louisiana has been estimated at 6,100 miles in 1984 (U.S. Army Corps of Engineers, 1984b). For pipelines, estimates of the total number and linear extent vary widely. Between October 1980 and January 1983, coastal use permits were granted for 860 buried pipelines in the Louisiana coastal area.

Canalization contributes directly to the loss of wetlands through dredging activities, spoil disposal and canal widening, and indirectly through hydrologic interruptions. Canals also act as conduits for the inland movement of comparatively saline water which damages freshwater wetlands.

Well site construction activities include the construction of board roads and ring levees. Ring levees are approximately 4-acre impoundments constructed around a well site. The area of wetlands impounded by ring levees during the past decade is probably extensive.

Although no specific information is available at this time, the disposal or leakage of saline water into wetlands may have a significant local impact near well sites.

Limited research has been conducted in Louisiana on the effects of hydrocarbon extraction on surface subsidence. A recent study in Louisiana indicates that there is a correlation between anomalous subsidence and drilling operations (Trahan, 1984, Personal communication). In Texas and other coastal oil and gas producing regions where the problem has been more extensively studied (California and Venezuela), oil companies are required to address the issue of subsidence in their development plans and take appropriate corrective measures (Boesch et al., 1983).

(2) Channelization, Dredging, and Mississippi River Flood Control Measures

The establishment of intercoastal waterways, irrigation and drainage canals, and access channels has resulted in extensive channelization and attendant disposal of dredge spoil throughout the coastal zone. Cuts have been made on land and in bays, estuaries, and tidal flats. Major environmental consequences of channelization and disposal of spoil in banks and piles are: (a) alteration or modification of on-land drainage patterns; (b) tendency to dam wetlands and shallow water bodies into isolated compartments, inhibiting natural circulation and altering temperature and salinity gradients; and (c) creation of unstabilized, easily eroded sediments that are reworked and redistributed by storms, normal waves, currents, and stream runoff.

Alterations in the hydrology of the Mississippi River basin have caused declines in sedimentation rates and have contributed to marsh deterioration in the coastal wetlands of Louisiana in recent decades. Coastal marshes appear to expand or diminish in areal extent according to the amount of sediment available, and sedimentation is the limiting factor controlling marsh growth. It is a natural system; overbank flooding is a major mechanism of introducing sediment-laden waters into adjoining wetlands. Therefore, flood control levees on the lower Mississippi River and its distributaries have resulted in wetlands loss because levees eliminate overbank flooding and prevent the distribution of alluvial sediments across the delta.

Sediment deprivation is also the result of a decrease in the sediment load of the Mississippi River as a result of river bank stabilization projects and upstream reservoir regulations. Land use changes, such as scientific soil conservation and reforestation programs within the basin, may also have contributed to the decrease in suspended sediment load of the river.

(3) Filling and Land Reclamation

Artificial filling of shallow coastal water bodies and low-lying marshes creates valuable shorefront development land or additional land for industrial expansion. The process also permanently destroys parts of vital natural environments, alters shoreline configurations, modifies natural patterns of circulation and sediment dispersal, and commonly creates unstabilized and easily erodable substrates.

(4) Shoreline Construction

Construction of groins, piers, and jetties, as well as channel widening and deepening and dredge disposal, have modified the circulation and sediment availability and transport patterns along the Gulf coastline and within the bays and estuaries. The erosion and accretion of a shoreline is largely controlled by natural processes, of which sediment supply and wave energy are key factors. Shoreline construction, whether in the form of shoreline control or development, can affect the natural processes and the rate at which they work.

(5) Waste Disposal

A significant activity in the coastal zone is the disposal of waste, particularly in the more populated and industrialized areas. Although many wastes are treated and discharged into water bodies and others are incinerated, a large volume of wastes are disposed of beneath or on land. Land disposal of waste may result in pollution of groundwater aquifers or surface water bodies in the event the host soils are permeable and the groundwater table is high.

e. Natural Events and Processes

(1) Natural Catastrophies

Several kinds of major natural processes create particular problems in the coastal zone. These include: hurricanes, which, through high and intense flood surges, may breach barrier islands and dunes, flooding low-lying coastal areas; shoreline erosion under normal and storm conditions; inland flooding along floodplains; and surface faulting and land subsidence.

(2) Natural Oil and Gas Seepage

Historical and contemporary data indicate that hydrocarbon seepage has been, and is, occurring in the Gulf of Mexico and elsewhere in the petroleum provinces of the world. It has proven difficult to pinpoint oil seeps in the deeper water areas of the Gulf, although many areas having anomalous concentrations of hydrocarbons in the water column are recorded on subbottom profiler records. They have also been detected and analyzed with chemical "sniffers." Some of these seeps occur at a considerable distance from commercial production.

(3) Submergence of Coastal Wetlands

The submergence of coastal wetlands in the Gulf of Mexico region contributes to a loss of 50 square miles of land per year in coastal Louisiana. Recent studies indicate that the submergence rate in Louisiana is 1.2 cm per year. The submergence rate at which wetlands deteriorate is variable depending on local sedimentation rates. The submergence rate critical for the stability of Louisiana marshes has not been determined. The major natural factors contributing to this submergence are: (a) a eustatic rise in sea level and (b) coastal subsidence. An additional discussion of these factors is provided in Appendix D of Final EIS 94/98/102.

During this century, the rate of rise of sea level has increased to 12 cm per century (Gagliano et al., 1981) and therefore may account for 10% of the observed submergence in Louisiana. It is not known whether this modern acceleration in the rate of rise of sea level is a short-term deviation from a slower long-term rate or whether it is a continuing process associated with a global climatic warming trend.

Approximately 90% of the submergence of coastal wetlands in Louisiana is the result of subsidence of the land (DeLaune et al., 1983). The primary processes responsible for land subsidence are geosynclinal downwarping; compaction, dewatering, and flow of recent sediments; and fluid withdrawal (hydrocarbons and water). It is not possible to quantify the contribution that each of these processes makes to the observed subsidence in coastal Louisiana.

3. Low and High Find Scenarios

Low and High Find Scenarios and the tables with assumptions are described and analyzed for Central Gulf Sale 110 in Section IV.D.1.d. and for Western Gulf Sale 112 in Section IV.D.2.d.

4. Impact Producing Factors Related to Routine Offshore and Onshore Support Activities

a. Effluent Discharges

Treated Sanitary and Domestic Wastes

Wastewater resulting from offshore activities include deck drainage, solid wastes (i.e., sanitary and domestic wastes), cooling water, and desalinization unit discharges. Deck drainage is all waste resulting from platform washing, deck washings, tank cleaning operations, and runoff from curbs and gutters, including drip pans and work areas. Sanitary wastes are personnel wastes from toilets and urinals, and domestic wastes are materials discharged from sinks, showers, laundries, and galleys. Cooling water is defined by USEPA as "noncontact" water used for cooling machinery, and desalinization discharges are those wastes resulting from the creation of freshwater from seawater. These discharges are regulated by USEPA through the National Pollutant Discharge Elimination System (NPDES).

The volume and concentration of sanitary wastes will vary widely with time, occupancy, platform characteristics, and operation situation. Toilets are usually flushed with brackish water or seawater in offshore operations. Due to the compact nature of these facilities, the wastes have less dilution water than common municipal wastes and results in greater waste concentrations. Concentrations of fecal coliform bacteria serve as an indicator of the potential pathogenicity of water resulting from the disposal of human waste. The presence of specific levels of suspended solids and chlorine residual in an effluent are indicative of corresponding levels of fecal coliform. If the suspended solid levels in an effluent are less than 150 mg/l and the chlorine residual is maintained at 1.0 mg/l, then fecal coliform levels should be less than 200 per 100 m. Properly operating biological treatment systems on offshore platforms have effluents containing less than 150 mg/l of suspended solids; therefore, chlorine residual is a reasonable control parameter. Any impacts on the water quality of receiving waters of discharges meeting USEPA requirements will be minimal and may be expected to be confined to an area within a few meters of the discharge site.

Estimates of typical volumes of sanitary and domestic wastes of offshore facilities have been developed by USEPA (1976) and are shown in Table IV-10 below.

Table IV-10

Typical Raw Combined Sanitary and Domestic Wastes from Offshore Facilities

Number of Inhabitants	Flow (gal/day)	BOD (mg/l)		Suspended Solids (mg/l)		Total Coliform (x 10)
		Average	Range	Average	Range	
76	5,500	460	270-770	195	14-543	10-180
66	1,060	875	-	1,025	-	-
67	1,875	460	-	620	-	-
42	2,155	255	-	220	-	-
10-40	2,900	920	-	-	-	-

Treated Drilling Muds and Cuttings

The discharges made in drilling OCS oil and gas wells have recently been the subject of research and public debate with regard to their potential effects on the marine environment. A lack of scientific consensus about the physical fates and biological effects of these discharges has led to actions contesting the permitting of some drilling discharges. The following discussions were taken from the National Academy of Sciences (1983) and the Final Regional EIS (USDI, MMS, 1983a).

Drilling fluids are required in rotary drilling for oil and gas exploration and development to remove cuttings from beneath the bit, to control pressure in the well, to cool and lubricate the drill string, and to seal the well. There are no alternatives to using drilling fluids in this rotary drilling. Although drilling fluids are recirculated during drilling and sometimes can be held and reused in drilling multiple production wells, eventually they must be disposed of because of their contamination with suspended material, their loss of important properties, or the weight and space limitations on drilling vessels. Cuttings from the formation drilled are removed from the drilling fluid and must also be disposed of. Although drilling discharges can be barged ashore or to other sites at sea for disposal, cost and operational Sales 72, 74, and 79 considerations favor onsite disposal by either overboard discharge or shunting through a pipe to some depth. Land disposal is now required for certain drilling fluids (for example, oil-based drilling fluids) and in certain State waters (State waters of Alabama).

Drilling fluids used on the OCS are composed of bulk constituents and special purpose additives. The principal bulk constituents are water, barite (barium sulfate), clay minerals, chrome lignosulfonate, lignite, and sodium hydroxide. All these constituents are nontoxic to marine organisms at the dilutions reached shortly after discharge. There is limited information on the compositions and quantities of additives in used fluids discharged on the OCS. Several common drilling-fluid additives, including biocides and diesel fuel (No. 2 fuel oil), are much more toxic to marine organisms than the bulk constituents.

Drilling fluids consist of a number of materials and chemicals added to water to perform a variety of functions necessary to the drilling operations (Offshore Operators Committee, 1976). These fluids, commonly called "muds," perform a variety of functions in drilling a well, such as cooling the drill bit, maintaining downhole pressure, and bringing cuttings to the surface. For detailed descriptions of the use of muds, see Appendix E of the Final EIS for Sale 65 and Offshore Operators Committee (1976).

Using 10,000 feet as an "average" well depth, estimated total volumes of muds and cuttings discharged resulting from both sales are as follows (using figures from Offshore Operators Committee, 1976): (1) exploration and delineation under the M Scenario (Table IV-1), 680 wells (360 in the CPA, 320 in the WPA), 347,480 yd^3 of cuttings (183,960 yd^3 in the CPA, 163,520 yd^3 in the WPA), and 3,094,000 bbls of muds (1,638,000 bbls in the CPA, 1,456,000 bbls in the WPA); and (2) production, 370 wells (200 in the CPA, 170 in the WPA), 189,070 yd^3 of cuttings (102,200 yd^3 in the CPA, 86,870 yd^3 in the WPA), and 1,683,500 bbls of muds (910,000 bbls in the CPA, 773,500 bbls in the WPA). This is a great deal of material, but it must be kept in mind that these amounts will be discharged into a very large body of water in which dilution and dispersion is rapid (i.e., four or five orders of magnitude within 10 m of the discharge point) and that such discharges will be over a period of several years. Assuming that drilling from these proposals takes place over 13 years, an average of 80,770 tons of mud solids per year will be discharged.

Approximately two million metric tons (dry weight) of drilling-fluid components are discharged annually on the United States OCS; more than 90% of this amount is in the Gulf of Mexico. Corresponding figures in the future will depend on government leasing policies, successes in exploration, and economic factors; but, in the near future most drilling discharges are likely to occur in the Gulf of Mexico and off southern California and Alaska. Compared to the mass emissions of river sediments and those of municipal wastes and dredged material, the quantity of drilling fluids discharged in the ocean is small. For example, total particulate loading in the Gulf from drilling fluids represents about 1% of that from the Mississippi River. Annual discharges of dredged material, sludge, and industrial wastes in United States coastal waters exceed those of drilling fluids.

Discharges of drilling fluids and cuttings into OCS waters take place in a wide range of marine environments, which vary greatly in water depth, ice cover, tidal and nontidal currents, waves, geological history, land runoff, and biotic characteristics. Thus, the physical fates of discharges, drilling fluids, and cuttings vary greatly. On the OCS, approximately 90% of the particles in discharges, drilling fluids, and almost all of the cuttings settle rapidly, passing through a stage of convective descent until encountering the seabed or becoming neutrally buoyant. In addition to the main, or lower plume, a visible or upper plume is also formed. Most observations of water column fate have focused on the upper plume and on the dispersion of dissolved components. Based on observations of upper plumes, the plumes are spread out at some depth appropriate to density characteristics and are rapidly dispersed by the turbulent diffusion characteristics of the ocean. Horizontal turbulent diffusion results in dilution of the plumes by a factor of 10,000 or more within an hour of release and an even greater dilution of suspended components because of settling. In deeper water, the lower plume reaches a condition of neutral buoyancy before it encounters the seabed. Thus, both plumes are of interest in water column fate considerations. At this time, virtually all field measurements of drilling fluid solids and soluble component concnetrations in the water column have been made on the upper plume. Laboratory measurements and model calculations indicate that concentrations in the lower plume are approximately an order of magnitude higher than in the upper plume (Brandsma and Sauer, 1983).

More than 96% of the whole drilling fluids tested in short-term experiments (from 44-144 hours) have LC_{50} values greater than 1,000 ppm (which are achieved in offshore oil and gas drilling activities only within a few meters of the discharge point) and are classified as "slightly toxic" or practically "nontoxic" by the IMCO et al. (1969) characterization of toxicity. More than 98% of the tests that have used the suspended particulate phase of drilling fluids found their LC_{50} values greater than 10,000 ppm (in the range of "practically nontoxic"). This distribution of toxicities, representing over 70 drilling fluids and more than 60 species of marine organisms, indicates that most water-based drilling fluids are relatively nontoxic (NAS, 1983).

There is concern regarding the environmental impacts of these drilling muds and cuttings. A 3-day symposium on Research on Environmental Fate and Effects of Drilling Fluids and Cuttings was held in Orlando, Florida, on January 21-24, 1980 (Symposium, 1980). Based on that symposium and numerous reports of government- and industry-sponsored research, two positive statements can be made: (1) many muds used in normal offshore drilling operations do indeed contain materials (such as chromium) toxic to marine organisms, but only at concentrations four or five orders of magnitude higher than those found more than a few tens of meters from the discharge point; and (2) dilution is extremely rapid in offshore waters to the extent that every substance measured in the water column, including turbidity, is at background certainly by a distance of 2,000 m, and probably within 1,000 m. Neff

(1981) and Petrazzuolo (1981) confirm this. Menzie (1983) states that in several studies of the effects of drilling effluents that "Bioassays had revealed that the drilling discharges had little toxicity and it was thought unlikely that the observed effects were the results of toxicants." The observed effects were reduced benthic invertebrate abundance and were attributed to a change in sediment type (see below). In another study performed for Exxon, drilling fluids were discharged into Gulf waters at a high rate. The study (Ecomar, Inc., 1980) came to the following conclusions:

> Due to settling and dilution, suspended solids levels and metal concentrations drop quickly with distance near the discharge source. Concentration decreases of three to four orders of magnitude occur within 100 m downcurrent of the discharge source. Concentrations continue to fall, but at a slower rate, as the plume moves further away. Concentration decreases of five to six orders of magnitude occur at distances of 500-1,000 m. Soluble component concentration decreases were estimated to be some two orders of magnitude less than those observed for the suspended solids.

Furthermore, the National Academy of Sciences (NAS, 1983) made a comprehensive study of the fate and effects of drilling fluids in the marine environment. Because of the authoritative nature of the NAS review, the conclusions of that report were extensively summarized in Section IV.D.1.a.(2) of Final EIS 94/98/102. In brief, the report concluded:

> This review of existing information on the fates and effects of drilling fluids and cuttings on the OCS shows that the effects of individual discharges are quite limited in extent and are confined mainly to the benthic environment. These results suggest that the environmental risk of exploratory drilling discharges to most OCS communities are small. Discharges from oil and gas field development drilling introduce greater quantities of material into the marine environment over longer periods of time. Results of field studies suggest that the accumulation of materials from these longer-term inputs is less than additive and therefore the effects of exploratory drilling provide a reasonable model for projecting the effects of development drilling. Uncertainties regarding effects still exist for low energy depositional environments which experience large inputs of drilling discharges over long periods of time.

Based on the NAS findings, it is evident that drilling fluids used on the OCS are not likely to cause any significant ecological damage beyond 1,000 m from the discharge point either in the short-term or the long-term. At most depths typical of the continental shelf, the majority of discharged fluids and cuttings are initially deposited on the seabed within 1,000 m of the point of discharge. This material may persist as initially deposited or may undergo rapid or prolonged dispersion, depending on the energy of the bottom boundary layer. Effects on benthos have been observed in the field, under low to moderate energy regimes, within 1,000 m of the discharge point.

This view was even more recently reiterated. At a "Mobile Bay Area Drilling Fluids Transport Workshop" held on December 6-8, 1983, the Biological Resources subgroup came to the following conclusion:

> We recognize that some area around the drilling activity (roughly a 200 m radius area) will be essentially buried by drilling cuttings and muds, and thus it is essential that such activities not take place immediately upon areas of particular biological concern or sensitivity (such as oyster reefs; coral reefs). This burial may result in the death of many benthic organisms, but recovery is generally rapid, depending upon several factors such as depth of burial and the extent to which the grain size of the discharged materials differs from that of the natural sediments. Dispersion of the cuttings pile and biological reworking of the materials takes place quickly, on the order of several months to a year. Toxicity does not seem to be a problem at the concentrations of material found at distances greater than 200-500 m from the discharge point, and certainly not at distances greater than 1,000 m. Most of the toxicity seems to be due to the presence of 3%-6% diesel oil in the discharges. Eliminating the use of diesel may reduce toxicity to insignificant levels. Mechanical damage to hard bottom communities from rig, platform, and pipeline emplacement and from anchors from crew, supply, and work boats is probably the greatest threat to such areas from oil and gas activities and should be avoided.

In addition to toxic effects, the discharges, particularly the cuttings, form a low mound on the bottom beneath the discharge. Approximately 511-961 yd^3 of cuttings are disposed of during the drilling of an exploration well, depending on the depth of the well. Nonmotile plants and animals covered by this mound may be smothered, and to the extent that this mound exhibits different substrate characteristics (such as grain size, organic content, etc.) from the original bottom, the plants and animals which colonize the mound will be different. However, observations on such mounds show that they are colonized and reworked, and that after some period of time become indistinguishable from the surrounding bottom (Zingula, 1975). Furthermore, Menzie (1983) points out that it is the physical change of the substrate rather than any toxic effects which causes a change of benthic fauna around drilling rigs.

All the above notwithstanding, the direct discharge of muds and cuttings on small and productive areas such as coral reefs and live bottoms would devastate delicate ecological relationships, and the resulting change in sediment characteristics could prevent recovery of the predrilling condition.

Produced Waters

Formation waters or produced waters are classified as all waters and particulate matter associated with oil and gas producing formations. The lower edge or down-dip boundary of most oil and gas pools is marked by an oil-water or gas-water contact. The amount of produced water generated is primarily dependent on the method of oil production, field characteristics, and location. As oil and gas production declines, most wells produce increasing amounts of free water; therefore, the age of a production field can impact the quantity of wastewater generated. In some pools, water comes with the oil in early stages of development; whereas in others, appreciable water never comes up with the oil. The period prior to initiating treatment of these waters is variable, depending on the characteristics of the particular field, and can be affected by the method of recovery.

Produced water production may vary from less than 1% to 90% of the production fluids. These waters may be high in total dissolved solids (TDS), oxygen demanding wastes, and toxic materials, in addition to oil and grease contaminants, as shown in Tables IV-11 and IV-12. Typical sodium concentrations range from 23,000-57,000 mg/l with typical calcium concentrations existing between 2,500-25,800 mg/l and those for magnesium from 100-5,000 mg/l.

Metal ions present in the highest concentrations are those which are common either to seawater or many terrestrial deposits and are not considered hazardous at the low concentrations observed, except those very close to the discharge source. Those metals generally considered as toxic are present at very low concentrations, often below the level of detection of even the sensitive methods used. The metals which would be of greatest concern in the environment are those which are toxic in concentrations of parts per million or less. To consider any possible hazards in discharging produced waters containing toxic metals in the marine environment, it is necessary to consider: (1) the concentration of trace metals in produced waters; (2) the concentration of trace metals in normal seawater; and (3) the toxicity levels of toxic metals. With the exception of Cu, Cr, Mn, and Sr, the concentration of trace metals in produced waters is not much different than that normally found in seawater. The six most toxic elements for marine organisms are considered to be mercury (Hg), cadmium (Cd), silver (Ag), nickel (Ni), selenium (Se), and lead (Pb). Produced waters do not normally contain concentrations of these six elements greater than those found in seawater. Attention has been paid to the determination of the two most toxic elements (Hg and Cd) in effluents from a number of crude oil offshore production units. In essentially all samples examined, values were below the levels of detection, which were 500 ppb for Cd and 0.5 ppb for Hg. Of lower toxicity, but still of concern, are copper (Cu), chromium (Cr), arsenic (As), zinc (Zn), and manganese (Mn). There seems to be no damage caused by the low levels at which these trace elements are present in produced waters (Offshore Operators Committee, 1975).

In addition to the possible toxic environmental effects of trace elements in offshore produced waters, there are some additional components and properties of produced waters which have a potential for minor environmental effects. These are salinity, dissolved oxygen, organic compounds other than hydrocarbons, and temperature.

The following discussion is taken largely from the Offshore Operators Committee's 1975 report:

> *Salinity*: Many offshore produced waters have higher concentrations of dissolved solids than the waters surrounding the platforms. The average total dissolved solids content for produced formation waters from offshore Louisiana production facilities is approximately 110,000 mg/l (ppm), compared with 35,000 mg/l for normal seawater. When dealing with dissolved

Table IV-11

Gulf of Mexico Produced Water Composition - Major Constituents

			Reference 1			References 2, 6, 3		Reference 4	Reference 5
Parameter	Units	X	Median	Range	X	Median	Range	Range	Typical
Physical Properties									
temperature	°C	38.1	39.2	22.6-48.2	20	20	20-21	-	-
specific gravity	-	1.110	1.101	1.073-1.151	-	-	-	-	-
surface tension	dynes/cm	63	62	57-68	-	-	-	-	-
Major Constituents									
pH	-	6.6	6.6	6.2-7.1	6.45	6.35	5.82-7.60	-	-
TDS	mg/l	129,950	114,000	80,500-203,000	102,172	107,353	11,273-199,313	169,000	-
SS (or TSS)	mg/l	-	-	-	45	41	18-87	12-656	-
CL	mg/l	-	-	-	60,283	60,518	16,667-115,481	42,000-62,000	-
SO_4	mg/l	-	-	-	9	0	0-69	-	300
K	mg/l	-	-	-	-	-	-	-	-
Sr	mg/l	-	-	-	-	-	-	-	85
Fe (total)	mg/l	-	-	-	29	-	8-100 (Ref. 3)	-	-
Mn	-	-	-	-	-	-	-	-	4
Composite Organics									
oil (GR)	mg/l	39.0	37.0	7.6-77	-	-	-	-	-
oil (IR)	mg/l	56.0	43.5	15-106	-	-	-	-	-
COD	mg/l	-	-	-	-	-	-	182-582	-
BOD	mg/l	-	-	-	-	-	-	126-342	-
TOC (TOC mgC/L)	mg/l	-	-	-	404	463	68-661	-	-

References:

1. Jackson et al., 1981 (10 offshore Louisiana platforms).
2. Myers et al., 1975 (25 Gulf Coast platforms).
3. U.S. Environmental Protection Agency, 1980.
4. Train et al., 1976.
5. Goodman and Troake, 1982.
6. Lysyj, 1982 (6 Gulf Coast platforms)

Source: Arctic Laboratories et al., 1983.

Table IV-12

Gulf of Mexico Produced Water Composition - Trace Constituents

Parameter	Units	Reference 2		Reference 3		References 1, 4		
		X	Range	X	Range	X	Median	Range
Trace Organics								
benzene	mg/l	3.5^a	0.18 - 14.0	0.836	0.170 - 1.90	1.955	1.229	0.137 - 11.335 (Ref. 4)
toulene	mg/l	2.4^a	0.16 - 7.95	2.074	0.770 - 3.30	-	-	-
ethylbenzene	mg/l	0.23^a	0.028 - 0.55	0.101	0.042 - 0.200	-	-	-
naphthalene	mg/l	0.148^a	0.018 - 0.300	0.027	0.012 - 0.044^g	-	-	-
phenol	mg/l	1.00^a	0.20 - 3.40	0.486	0.018 - 0.840	2.203	0.808	0.108 - 20.812 (Ref. 4)
2,4-dimethylphenol	mg/l	0.132^a	0.016 - 0.570	-	-	-	-	-
bis(2-ethylhexyl) phthalate	mg/l	0.028^a	0.016 - 0.118	-	-	-	-	-
di-n-bitylphthalate	mg/l	0.010^b	0.010 - 0.010	-	-	-	-	-
benzo(a)pyrene	mg/l	0.016^b	0.012 - 0.021	-	-	-	-	-
2,4-dinitrophenol	mg/l	0.127^c	-	-	-	-	-	-
fluorene	mg/l	0.017^c	-	-	-	-	-	-
phenanthrene	mg/l	0.235^c	-	ND	ND	-	-	-
Trace Metals								
Ag	mg/l	-	<0.050 - $<0.87^d$	-	0.001 - 0.152^e	-	-	<0.01 - 0.01 (Ref. 1)
As	mg/l	-	-	-	<0.005 - 0.05^e	-	-	<0.01 - <0.02 (Ref. 1)
Cd	mg/l	-	0.028 - <0.044	-	<0.025 - 0.056^f	-	-	<0.02 - 0.103 (Ref. 1)
Cr	mg/l	-	<0.13 - <0.25	0.260	<0.059 - 0.390^f	-	-	<0.10 - 0.23 (Ref. 1)
Cu	mg/l	-	<0.091 - 0.014	-	<0.025 - 0.137^f	-	-	<0.10 - 0.28 (Ref. 1)
Hg	mg/l	-	-	-	<0.0003 - $<0.001^e$	-	-	<0.001 - 0.13 (Ref. 1)
Mn	mg/l	-	-	-	-	-	-	- (Ref. 1)
Ni	mg/l	-	0.31 - <0.25	-	<0.068 - 1.674^f	-	-	<0.10 - 0.44 (Ref. 1)
Pb	mg/l	-	<0.50 - <1.2	0.597	<0.16 - 0.915^f	-	-	<0.01 - 0.22 (Ref. 1)
Zn	mg/l	-	0.028 - 0.32	0.350	<0.025 - 0.640^f	-	-	0.10 - 0.27 (Ref. 1)

Notes:

[a] By GC-MS (gas chromatography-mass spectrometry); all values are averages of results derived by internal standard and isotope dilution determination.
[b] Above detection limit at two platforms.
[c] Above detection limit at one platform.
[d] By standard addition AAS (atomic absorption spectrometry).
[e] By flameless AAS.
[f] By plasma emission spectrometry.
[g] Detected in three of six platform effluents.

ND - not detectable at 1 μg/l.

Source. Arctic Laboratories et al., 1983.

References:

1. Train et al., 1976.
2. Radian Corporation, 1982 (six Gulf Coast platforms).
3. Lysyj, 1982 (six Gulf Coast platforms).
4. Mors et al., 1982.

components, dilution occurs quite rapidly when the produced waters are discharged into the waters surrounding the platform. Any toxic environmental effects will be extremely localized near the point of discharge. Dilution in large water bodies and in comparatively deep water is very rapid, and according to Stolzenbach (1982), dilutions of 50-100 parts of seawater to one of brine can be effected in even comparatively shallow water at a distance of 8-50 feet from a single source of discharge, with smaller flows facilitating a greater dilution on the order of 100:1.

Salinity measurements were made at 180 different sampling stations offshore and in Timbalier Bay, Louisiana (GURC, 1974). Variations could be correlated with season and geography of sampling sites and all variations were within the ranges reported by season.

Dissolved Oxygen: Dissolved oxygen (DO) is a water quality constituent that, in appropriate concentrations, is essential to keeping marine organisms living, and sustains species reproduction and population development. Marine organisms tend to undergo stresses at reduced DO concentrations that make them unable to sustain their species within the adequate environment. The GURC (1974) study found that natural processes (tides, floods, droughts, etc.) completely overshadowed any changes in DO content which might have been caused by the discharge of production waters. Reduced levels of DO may cause "dead" areas in which marine organisms are unable to live. No significant depletion of oxygen was observed at platform sites and what small reduction was noted could be explained by the generally rich biota living on platform legs.

Organic Compounds Other than Hydrocarbons: Other organics found in platform production waters will usually be present in even lower concentrations than the petroleum hydrocarbons associated with these waters. These other organics would likely be in the low ppm range, and dilution would rapidly disperse them below the limits of toxicity and hence of any adverse environmental effects. In the GURC study, measurements were made of the organic carbon content in the waters around two producing platforms and a control area some six miles away. Typical organic carbon contents measured around the platforms were 5.8 and 5.0 mg/l (ppm), respectively, and 5.1 mg/l (ppm) for the control area. Since these values are all within the sampling variability, it was indicated that there was no significant buildup of organic compounds in the vicinity of the producing platforms.

Temperature: Production waters tend to be somewhat warmer than the water surrounding the platforms. As with dissolved organics, dilution would rapidly diminish any temperature gradients. In the GURC study, temperature measurements were also made at some 180 different sampling station offshore and in Timbalier Bay, Louisiana. As was found with salinity, the temperature variations correlated with season and nearness to shore, and no impact of the platforms and their discharges on the water temperature was noted. Long-lasting elevated temperatures could cause a change of community structure.

Environmentally high concentrations of naturally occurring radionuclides are found to exist in oil field production waters. High levels of Ra-226 are common in the production waters from Gulf coast oil fields as evidenced in Table IV-13.

These levels are up to four levels of magnitude higher than levels found in open ocean surface waters which normally contain 0.05 pCi/l (picocuries per liter) of radium.

Some of these oil field brine values range from approximately 40-1,000 pCi/l with geothermal brines ranging from approximately 40-1,000 pCi/l for Ra-226 and 40-500 pCi/l Ra-228. In contrast, salt dome brines produced by the Strategic Petroleum Reserve Project are very low in Ra-226, ranging from 0.4-3.1 pCi/l in samples analyzed. The sources of radionuclides in formation waters are naturally occurring minerals in shales and sandstones. Radium in freshwater sources is typically bound to suspended particles but desorbs into solution when exposed to saltwater as the freshwater enters estuaries or bays.

Despite the higher levels in formation water as compared to open seawater, there seems to be no apparent human health or environmental contamination problem because of the rapid dilution of these formation waters when discharged offshore. On land, formation waters are typically reinjected or disposed of down disposal wells. There are some instances of discharges into coastal marshes, however, which might allow accumulation of these materials in sediments or biota.

Table IV-13

Radium Content of Some Gulf Coast Oil Field Production Brines

Identification	Ra-226 (pCi/l)	Ra-228 (pCi/l)
Bay de Chene, LA	327±5	426+26
Houma District, LA	131±3	170±11
Lafayette District, LA	298±5	328±20
Grand Island, LA	144±4	202±13
Garden Island Bay, LA	393±7	570±34
Grand Bay, LA	183±4	---------
Leeville, LA	321±20	385±30
Leeville, LA	254±12	318±22
Empire, LA	199±6	---------
High Island, TX	313±4	407±29
Pelican Island, TX	16±5	---------

Source: Reid, 1980.

Current Nuclear Regulatory Commission regulations governing the operations of licenses permit no more than 30 pCi/l in liquid discharges to unrestricted access areas, and standards for drinking water are set not to exceed 5 pCi/l. Based on the proposed definition of waste hazardous by virtue of radioactivity, oil field production brines and geothermal brines could be classified as radioactive hazardous wastes and regulated under the standards promulgated in response to the Resource Conservation and Recovery Act of 1976 (Reid, 1980).

Current treatment technology developed for each area of the country is influenced by local regulation requirements set forth by water quality, State and local laws. This technology primarily consists of oil removal prior to subsurface disposal or oil removal prior to open water discharge. The sophistication of the treatment employed is dependent upon the regulations governing such discharges. OCS Order No. 7 requires that all discharges must meet USEPA standards which allow no more than 72 mg/l daily maximum of oil and grease discharge and 48 mg/l maximum monthly average (72 mg/l is equivalent to 42 ppm). Treatment systems on offshore platforms are usually limited to meet the needs of the immediate production facility and are designed for 5,000-40,000 bbls/day. Smaller facilities may require intermediate waste storage and a transport system to deliver the produced water to another facility for treatment and disposal.

In April 1982, an unpublished report entitled "The Discharge of Water Pollutants from Oil and Gas Exploration and Production Activities in the Gulf of Mexico Region" by Gianessi and Arnold estimated the water pollutant discharges resulting from oil and gas exploration and production activities in the Gulf of Mexico region for a representative current year. This report is part of a larger assessment effort of the Gulf of Mexico by NOAA's National Ocean Service, Strategic Assessment Branch. This office has recently completed data gathering efforts for a Gulf of Mexico Data Atlas, which contains information on the physical and living environments, species, economic activities, and jurisdictions within the Gulf. The report stated that in addition to the produced water discharged directly to OCS waters (356,642 bbls/day), in 1976 OCS operators piped some 328,470 bbls of OCS produced waters per day to onshore locations where it was treated and subsequently discharged in inshore waters. Aside from OCS discharges of produced waters, it was also noted that approximately 840,000 bbls of saltwater are discharged per day in Louisiana coastal parishes and up to 700,000 bbls of brine per day are permitted for disposal to surface waters in Texas coastal counties.

Discharge of produced waters from normal oil and gas operations on the OCS are covered by OCS Order No. 7 which requires that all such discharges must meet USEPA permitting procedures pursuant to the Federal Water Pollution Control Act, as amended. The USEPA standard allows for a daily maximum oil and grease discharge of 72 mg/1. Brine discharges to surface waters in Louisiana are regulated for oil content by the Division of Water Pollution Control and oil/grease permit concentrations are set at 30 mg/1 and are assumed the same for produced water discharges into Louisiana tidal waters. Brine discharged into Texas tidal water requires a permit from the

Texas Railroad Commission and sets a limit on the daily water production by discharge point and an average of 15-25 ppm oil content.

Other Nonpoint and Point Source Pollution

The construction and operation of onshore facilities supporting OCS activities in the Gulf may impact local onshore water quality by increasing the number of point and nonpoint pollution sources. Increases of nonpoint waste sources due to site runoff may contribute particulate matter, heavy metals, petroleum products and chemicals to local streams, estuaries, and bays, causing temporary elevations in pollutant and turbidity levels. During site preparation the vegetation is cleared from the area, the topsoil is exposed, and the soil profile is altered by grading and leveling operations. The soil is compacted by the constant movement of heavy machinery, which in turn alters the retention properties of the soil and gives rise to increased erosion and runoff from the site. By controlling the erosion generated within the construction site boundaries, several of the adverse impacts can be localized and prevented from having offsite impacts on water bodies.

Land clearing and associated development changes the natural process of stormwater runoff, causing the volume and rate of runoff to increase as the natural vegetation is modified. Two major pollutants are contained in this runoff--suspended solids (organic and inorganic) from exposed soil at the site and contaminants such as heavy metals. Suspended solids may significantly decrease light penetration in water, thereby decreasing photosynthesis in aquatic plants. These may also cause abrasive injuries and gill clogging in fish and can smother eggs and larvae on the bottom. They may provide additional substrates for bacterial decay, leading to oxygen depletion of bottomwaters. Alternately, they may contain nutrients which increase growth rates of endemic plant and animal populations.

Impacts of heavy metals or other contaminants contained in runoff on receiving waters will depend upon two factors. The first is the nature of the runoff and the level of concentration of heavy metals. The second factor is the nature of the receiving waters and the species diversity. Some heavy metals are extremely toxic, even in low concentrations, while others have a cumulative effect as organisms ingest them. As in the case of shellfish water quality, changes may not kill the resource but may contaminate it so that it cannot be safely used for a human food source or taints the flavor of the source, making it undesirable for human consumption. These metals may also exhibit a toxic effect on consuming organisms higher in the food chain due to concentration increases with each step in the food chain (NERBC, 1976).

Increases of point source discharges may also contribute to effluent discharges of domestic wastewater, cooling and boiler water, process water, and in marine terminal areas, the discharge of ballast and bilge water. The following discussion on wastewater effluents discharged to surface waters by OCS-related support facilities is largely taken from NERBC (1976).

Wastewater effluents from OCS-related support facilities are commonly discharged to surface waters after treatment. Although the degree of environmental damage, if any, will be related directly to the toxic nature of the discharge and the biota in the receiving waters, certain characteristics of the discharge zone are important. These include: the size of the effective mixing zone (dilution factor) or the ratio of discharge volume to receiving volume; the flushing rate of residence time (estuaries characteristically have a slow flushing rate); and the physical-chemical characteristics of the receiving waters, e.g., marine waters have a higher buffering capacity than fresh or estuarine waters.

Cooling water represents a significant proportion (70%-100%) of the wastewater effluent from an oil refinery or gas processing plant. Table III-22 illustrated the potential water use for gas processing and refining operations within the Gulf coastal region. Over 40% of the water utilized will be removed through evaporative processes. Substances concentrated in the blowdown and heat added during the condenser cooling operations could produce serious impacts on the receiving waters. Chemicals added to the cooling water stream to reduce corrosion and fouling within the tower and the condenser system (including chromium and chlorine) may be extremely toxic to aquatic organisms. The presence of these substances could increase any adverse impacts of heated discharge on the receiving water body.

Domestic wastewater from support facilities will be collected and delivered to a municipal treatment plant or will receive secondary treatment in an onsite package treatment plant that includes chlorination prior to discharge to the receiving waters. Should these receiving waters also contain high organic carbon concentrations, organic chlorine compounds (e.g., chloroform and chloramines) which are highly toxic to certain aquatic organisms will be produced. Discharge of properly treated sewage wastewater into urban harbors is not expected to measurably degrade the receiving waters.

Although it does not constitute the greatest volume of water used in refining operations, process water may be the most contaminated. The processing pollutants are added during crude oil desalting, steam distillation, steam stripping, etc. In general, the quantity and hazardous nature of process water is a function of the size of the facility (in terms of barrels/day) and the degree of processing. Process water discharged from plants is of considerable volume and is highly toxic due to its anaerobic and highly reduced character and the presence of numerous heavy metals, sulfides, and ammonia which were produced together with the oil and gas. Three substances--mercury, cadmium, and cyanide--present in the effluents of OCS support facilities have been designated "toxic pollutants" pursuant to the Federal Water Pollution Control Act, as amended. Toxic pollutants are defined in Section 502(13) as "those pollutants, or combinations of pollutants, including disease-causing agents, which after discharge, and upon exposure, ingestion, inhalation, or assimilation into any organism, either directly from the environment or indirectly by ingestion through food chains, will, on the basis of information available to the Administrator, cause death, disease, behavioral abnormalities (including malfunction in reproduction) or physical deformations in such organisms or their offspring."

Wastewater effluents from OCS-related facilities produce a wide range of responses in the receiving waters. Environmental responses produced will depend upon the quantity and kind of pollutants discharged or spilled. Heavy metals (such as zinc or copper), although often essential or nontoxic to organisms in very low concentrations, become toxic in higher concentrations. Even if the concentration of a heavy metal in the water is not toxic, it may accumulate in tissues with ultimately lethal effects. Ammonia can alter the pH of water, thus harming pH-sensitive organisms. Antifouling substances, which are added to cooling water to kill algae and bacteria, have similar effects on the organisms present in the water into which they are discharged. Suspended solids significantly decrease light penetration into the water, thus decreasing photosynthesis in aquatic plants. They also cause abrasive injuries and gill clogging in fish and can smother eggs and larvae by blanketing a stream bottom. Suspended solids which settle on the streambed provide additional substrates for bacterial decay, leading to oxygen depletion of the bottom waters. Thermal discharges can alter the chemical nature of receiving waters in many ways. Solubility of dissolved oxygen, toxicity of heavy metals, and metabolic rates of aquatic organisms are affected by changes in water temperatures.

The environmental impacts associated with oil and heavy metal pollution in the marine environment include both toxic and sublethal responses. Juvenile forms of many species of marine fauna are particularly sensitive, and an age class may be totally eliminated by a specific dosage of oil or some heavy metal. Sublethal physiological alterations include depression of growth and photosynthesis in marine flora.

Point source discharges will be subject to treatment by municipal and industrial facilities in compliance with Federal and State discharge permit requirements. NPDES permits are issued on a facility-by-facility basis, limiting the quantities of contaminants in and the temperature of each facility's effluent. These limits reflect a site-by-site specific analysis of flushing and mixing zone rates of the receiving body and indigenous population's ability to tolerate elevations of temperature and pollutant concentrations.

b. Air Emissions

The major impact producing factors on air quality from OCS-related activity are due to combustion, evaporation, or venting of hydrocarbons. In the offshore environment, potential impact producing activity includes catastrophic events and operational emissions. Specifically, these events may be described as follows:

Offshore Activity

Catastrophic Events	Operations Emission
blowout with fire	exploratory drilling
oil spill (major)	platform installation
release of sour gas (nonflared blowout)	development drilling
	oil production
	gas production
	barge loading (where applicable)
	tankering

Refineries
Gas Processing Plants
Vessel Loading

In the onshore environment, potential impact producing activity includes the operation of oil refineries, gas processing plants, and vessel loading.

Offshore, effects of an immediate nature are those caused by catastrophic events such as blowouts with fire, major oil spills, or the release of free hydrogen sulfide (sour) gas. Air emissions from these sources are of a nonroutine nature and can be expected to last for a short period. However, due to the release of large quantities of hydrocarbons (in the case of an oil spill), nitrogen oxides (NO_X), sulfur oxides (SO_X), carbon monoxide (CO), total suspended particulates (TSP), volatile organic compounds (VOC) (in the event of blowout with fire), and hydrogen sulfide gas (H_2S) (from blowout-no-fire-in sour gas prone areas), effects that are of an immediate nature are likely to occur and in some instances could result in serious health hazards. A factor influencing the effects of such events is the volume of hydrocarbons released, the rate of release, and the distance to shore. Events that could occur on the OCS range from a minimum of 3 miles to as far as 200 miles from shore.

Blowouts, also being nonroutine events that may persist for many days or weeks, emit substantial levels of NO_X, SO_X, CO, and TSP when associated with fire. These emissions can be considered a point source and have the potential of dispersing over land areas under certain circumstances; this, of course, depends on the location of the event and wind conditions. Emissions from these sources further offshore have little potential of degrading onshore air quality; however, if such an event were to persist nearshore for some time, it may degrade onshore air quality to an unknown level (assumed to be low to moderate). If these events affect any nonattainment area or PSD Class I area, the consequences would be more serious than if it occurred elsewhere.

An unflared blowout in an area where sour gas exists could present serious health hazards within a radius of approximately three miles from the source. Concentrations of H_2S in excess of 400 ppm for 30-minute or less exposure are considered dangerous to humans and 700 ppm is estimated to be fatal to humans. Should an event occur, H_2S content of gas, local wind conditions, and other factors would control the impacts of the event. Uncontrolled emissions of this nature are unlikely to cause hazards onshore if the source is farther than approximately 4-5 miles offshore.

In the summer of 1984, two sour gas finds were publicly reported 3-5 miles south of Dauphin Island, Alabama. H_2S content was tested at 5,000 and 7,000 ppm for each exploratory well. Using these test results and assuming the most conservative (severe) conditions, a modeling effort to determine the dispersion characteristics of H_2S was undertaken. The conditions applied to the model included: (1) an unflared blowout above the water column; (2) three miles distance from shore; (3) a steady, gentle southerly wind; and (4) a persistent 26 million cubic feet/day duration. The results of this analysis indicate less than 1 ppm H_2S would be dispersed on the island. This level would probably not be detectable by human olfactory senses and would pose no threat to human or natural environments.

Other emissions due to offshore and onshore OCS-related activity create effects of a more long-term nature. Operational emissions from offshore activity and onshore activities typically emit constant levels of VOC, NO_X, CO, SO_X, and TSP. The levels of these emissions and the effect of these emissions on ambient air quality is of concern. Specifically, if normal operational emissions from these sources degrade the air quality of onshore areas such that the National Ambient Air Quality Standards (NAAQS) are exceeded, the threat may exist to the public health and welfare of the affected area. Many conditions define the magnitude of this threat, such as the number of pollutants present, the concentration (density) of the pollutant(s), and meteorological conditions by area over time. Typical emission levels are shown for exploratory drilling operations and platforms within the Gulf in Tables IV-14 and IV-15.

c. Noise Emissions

Noise emissions resulting from OCS development are associated with the operation of offshore platforms, drilling rigs, seismic geophysical surveying, petroleum transfer facilities, onshore processing plants, pump stations, aircraft, and vessels. In addition, construction equipment used during the installation of the various facilities emits

Table IV-14

Typical Emission for Exploratory Drilling Activity[1]
in the Gulf of Mexico
(tons)

NO_x	CO	SO_x	VOC	TSP
10.3	1.51	0.69	0.34	Unknown

[1] Assumes: 10,000′ hole; 597,120 hp/hr; and a 30-day period.

Source: U.S. Environmental Protection Agency, 1977.

Table IV-15

Typical Emissions for a Major Platform
in the Gulf of Mexico
(tons/year)

Equipment[1]	NO_x	CO	SO_x	VOC	TSP
3400 HP Turbine Generator	43	16	0.1	3.0	0.1
One Million BTU Heat Treater	2	0.2	0.1	0.1	0.1
600 HP Recip. Oil Pump	63	8.0	25	0.1	0.1
Total	108	24.2	25.2	3.2	0.3

[1] Assumed to be the most commonly used equipment based on current records compiled since June 1980 to the present.

Source: USDI, Minerals Management Service, Gulf of Mexico OCS Region.

various amounts of noise. The degree of noise impact depends upon the emitted sound level and the proximity of the source to schools, hospitals, residences, and recreation areas.

Machinery noise sources found on drilling and production platforms are, generally, similar to those used for shore-based operations. Special noise attenuated devices are sometimes used offshore to protect workers in their living quarters located on the platforms. Compressors and diesel engines are usually the loudest equipment on a typical platform emitting about 90 dBa at a distance of 15 m (50 ft). By comparison, a diesel truck under full load also emits about 90 dBa at 15 m. Although other sounds, such as banging of pipes may be more intense, they are of short duration. The possible impact of noise emissions on the biological environment is discussed in subsequent sections. This has a potential to degrade the underwater acoustic environment, and may also adversely affect Naval activities in certain areas.

In a quiet sea with light wind conditions, normal offshore platform operations would be inaudible beyond about 2 miles (assuming ambient background noise level of 40 dBa and attenuated due to sound wave spreading only). In rough seas and weather conditions, the offshore facility would be inaudible beyond about 1/8 of a mile (assuming 70 dBa background). No onshore noise impact is expected form normal operations of OCS platforms since even under low background noise conditions they would not be audible from shore. Onshore noise levels could be slightly increased by vessel, vehicle, and helicopter traffic; however, these increases are generally expected to be small. Gales (1982) points out that in light seas the subsea surface noise propagated by a platform could be detected up to 100 miles away.

Most of the onshore processing and support facilities would necessarily be located in industrially zoned areas where noise would have a minimal impact. If adverse noise impacts could result, mitigation measures such as sound barriers (i.e., earthen berms, block walls, etc.) and mufflers could be utilized. The site-specific noise impacts of these developments will be considered in future environmental documents when detailed development plans are known.

Human activities associated with OCS exploration and development, especially air and vessel traffic near nesting waterfowl and seabirds, could reduce productivity of some species and may cause abandonment of important nesting, feeding, and staging areas. Effects studies in the arctic indicate that arctic tern, black brandt, and common eider all show lower nesting success in undisturbed areas (Gollop et al., 1974). Schweinsberg (1974) reported that snow geese were particularly sensitive to aircraft disturbance during premigratory staging. The responses of birds to human disturbances are highly variable. These responses depend on the species, the physiological or reproductive state of the birds, distance form the disturbance, type, intensity, and duration of the disturbance and many other factors. Waterfowl nesting on deltas and islands may also be disturbed by aircraft and vessel traffic, and some disturbance of molting and staging birds is likely to occur. However, effects studies by Ward and Sharp (1974) and Gollop et al. (1974) indicate that long-term displacement or abandonment of important molting and feeding areas due to occasional aircraft disturbance is unlikely.

Aircraft and vessel traffic, and human presence associated with OCS-related oil/gas activities could adversely affect marine mammals which occupy overwintering, and breeding areas in or near sale areas.

Short-term responses of whales to accoustical disturbances that have been demonstrated include: flight and startle response; vacating of an area; deflecting of migration routes; and changes in swimming, diving, and respiration characteristics. The degree of responses ranged from those so subtle that statistical analysis was necessary to determine whether or not a change had occurred, to total abandonment of an area for several years and return only when historic ambient noise levels were restored. There are many areas where industrial noise had been ongoing for several years; whales have continued to utilize these areas, to some degree, during their migration cycle. If accoustical disturbances persist in critical areas, long-term effects may result. Long-term effects may include: permanent abandonment of some habitats, physical damage to the whale's auditory system, and changes in some portion or timing of their migratory cycle. Areas where long-term effects may be most likely to develop are in habitats where ambient noise levels do not presently include high levels of industrial noises (e.g., summer feeding areas and overwintering areas) or where many whales use a small area intensively. Habituation may be possible if increases industrial noise levels proceed at a very slow rate (20-40 years).

d. Physical Presence of Drilling Rigs, Platforms, Boats, and Barges

The exploration, development, and production of OCS resources consist of many phases of activity including the initial survey with medium to small size vessels, the placement of exploratory rigs, support from local bases utilizing crew and work boats, placement of platforms for long-term use, and the use of barges and work boats in support of production activities. All these activities affect their surroundings merely due to their presence in the area.

An increase in ship or boat traffic in an area may or may not have an impact on the area, depending on existing conditions. It is possible, however, that any increase in vessel traffic could pose additional transportation safety hazards in an area heavily traveled or particularly difficult to navigate. If existing port and supply facilities are to be used, and this is the assumption regarding activities resulting from these sales, increased usage may affect their adequacy to meet all commercial needs.

The presence of offshore rigs and platforms occasionally conflicts with commercial and sport fishing interest for space. However, this is often offset by the fish-attracting capabilities of the structures. Commercial fishing would be most affected by the presence of offshore structures. If a rig is placed in productive fishing grounds, commercial fishermen would assume the burden of safe navigation around these obstacles without entangling their gear.

All platforms and rigs are obstacles to local navigation. It is fortunate, however, that these structures are quite visible to mariners due to their size and lighting. One of the most pronounced factors regarding OCS activities is the visual impact these operations have on the surrounding area. The majority of the area offered is far offshore where structures do not interfere with the aesthetic value of the coastal areas. However, off Louisiana, blocks are being offered just beyond the 3-mile State/Federal boundary where potential OCS operations in these areas may impact the visual value of the surrounding area. On clear days, drilling rigs may be seen for a distance up to 15-18 miles from shore depending on the height of the drilling derrick.

Rig and platform emplacement will result in disruption and suspension of sediments only in the immediate vicinity of the site. Displaced material or the physical presence of the rig or platform can smother burrowing and attached benthos. Increased turbidity resulting from rig and platform emplacement can temporarily clog the respiratory organs of many marine organisms and the filter-feeding mechanisms of numerous others. This increased turbidity is a short-term phenomenon, and generally is not significant beyond a few hundred meters from the site of the rig, platform, or associated anchors.

e. Pipeline Construction

Federal offshore pipeline construction has been occurring in the Gulf of Mexico since 1951. By December 1984 the cumulative miles of OCS pipelines had reached 13,650 miles. Since 1970 annual pipeline construction has averaged about 600 miles. Data on the annual and cumulative amount of OCS pipeline construction and related landfalls included in the Central and Western Gulf are presented in tables included in Final EIS 104/105 (Tables IV-13 and IV-14).

Offshore and onshore oil and gas pipelines are considered impact-producing factors of special concern in the marine and coastal environments on the basis of potential space/use conflicts, displacement of bottom sediments, accidental oil spills, and other environmental perturbations. The Regional Environmental Assessment of Pipeline Activities, covering the northern Gulf of Mexico region and the contiguous coastal zone, discusses regulatory procedures pertaining to pipeline installation associated with the Federal oil and gas program, describes the affected offshore and onshore environment, and discusses environmental impacts of the construction of pipelines on the OCS and nearshore region of the Gulf of Mexico (USDI, MMS, 1983c).

The Regional Technical Working Group (Volume 1, Section I.B.3.b.(8) of the Final Regional EIS) has developed a Transportation Management Plan to identify acceptable land and water areas in each leasing region for pipeline installations.

The emplacement of a pipeline, by whatever technique, will always cause a certain amount of damage to the substrate. In coastal wetlands, habitat destruction and the outright elimination of the associated biota will be greatest. By placing the pipeline into marsh and/or swamp soil, marsh and swamp habitat is changed to open water or, due to the deposition of dredge spoil, to an upland habitat type. This results in a profound change in the vegetation types subsequently becoming established. Spoil banks lining pipeline canals often also seriously interfere with natural drainage patterns in coastal wetlands. If a pipeline canal remains as a straight open water body, saltwater instrusion into and accelerated dewatering of fresher marsh types occur, eliminating less saltwater tolerant vegetation. The loss of vegetation causes increasing erosion of marsh soils and ultimately, wetlands loss. Often, the pipeline emplacement methods employed will determine the severity and duration of adverse impacts on coastal habitats. Operation of heavy equipment in coastal marshes and swamps can be very destructive to these habitat types and their biota for many years.

The destruction of coastal wetlands habitat manifests itself in reduced commercial fisheries catches. Exact figures are lacking but coastal biologists and ecologists generally agree that there exists a relationship between coastal wetlands loss and a reduction in commercial fisheries landings.

Emplacement of pipelines in shallow bays, estuaries, nearshore areas, and in soft-bottom offshore areas will usually suspend much bottom sediment and organic matter, and with it, possibly nutrients, toxic heavy metals, and pesticides. These substances are then often re-introduced into the food chain. The attendant increase in turbidity is, although temporary, also detrimental to fish larvae and aquatic invertebrates because of clogging of gills and feeding structures. Displaced material from pipeline trenches will smother and/or displace sessile benthos. Recolonization of the disturbed areas depends on the types of organisms present and the kinds of substrates involved.

On hard bottom areas, emplacing a pipeline, by whatever technique, will eliminate the suitable sites for attachment of those organisms dependent on a firm substrate for attachment (sponges, corals, seaweeds, and sessile molluscs). Recolonization of an area disturbed by pipeline burial will depend on the species present and the time required for the substrate to compact to an acceptable degree.

In coastal wetlands, the severity of adverse effects of the presence of a pipeline depends on whether the pipeline is buried or whether an open canal has resulted from pipeline emplacement. In a marsh habitat, if a pipeline is carefully covered after burial and if the covering material is at the elevation of the surrounding marsh, revegetation by marsh species will occur and impacts will be minimal. If an open canal remains after burying the pipeline, saltwater intrusion and marsh soil erosion will adversely impact coastal wetlands. Open canals, however, sometimes provide excellent sport fishing.

In offshore waters, some gear conflict between commercial trawls and pipelines does exist. Adverse impacts are small, however. Further, buried pipelines often cause a slight elevation on the Gulf floor and attract fish and shellfish. This fact is recognized by some commercial fishermen, and pipelines in offshore waters are preferred fishing areas. The use of pipeline lay barge anchors during pipeline installation has the potential to adversely impact other offshore resources.

Oil spills that occur in coastal wetlands as a result of a leak or rupture in a pipeline usually cause severe and often long-term adverse impacts. Marsh vegetation, especially mangroves, are extremely sensitive to oil spills; subsequent cleanup operations are difficult, if not impossible, to conduct without causing additional damage to the vegetation. Recovery of coastal wetlands from an oil spill may range from several months to many years, depending on the severity of the spill and the vegetation involved.

A small acute or chronic oil spill in offshore waters from a pipeline would probably have very little impact on the commercial fishing industry, although an unknown number of fish and shellfish eggs and larvae could be destroyed. In shallow bays and estuaries that constitute nursery areas for many commercially important fish and shellfish species, an oil spill would be much more detrimental because larvae and juveniles of these species are more sensitive to spilled oil than adults.

Offshore pipelines are exposed to numerous hazards including corrosion, geologic hazards, hydrodynamic forces, and accidental damage caused by anchors or other objects. Pipeline corrosion can be internal or external and may result in leaks and/or breaks. Geologic hazards capable of causing pipeline failure are sediment instability and seismic activity. Delta areas (Mississippi and Atchafalaya Deltas) are considered particularly hazardous because of sediment instability. Sediment failure resulting from seismic activity, too, can place hazardous stresses on pipelines. To minimize the potential for pipeline failure resulting from such hazards, the information obtained during a preconstruction route survey is analyzed to determine the safest and most stable route for pipeline placement. Areas with active faults and mudfloor potential should be avoided or design measures should be implemented to reduce the potential risk of pipeline failures.

Hydrodynamic forces may remove sediment from around a pipeline and cause stresses from sagging and vibration if waterflow velocity is sufficiently high. Anchors, fishnets, or any other objects that may be dragged across or dropped upon a pipeline can also cause damage and possible leakage. Of 534 recorded pipeline leaks from 1967 to 1981, 61 were directly attributed to anchoring. To help alleviate this problem, pipelines are required to cross perpendicular to fairways and to be buried 10 feet below the bottom or as stipulated by COE. Pipelines in anchorage areas are generally required to be buried at least 16 feet. Under normal circumstances vessels do not anchor in fairways on the OCS, so conflict is unlikely. However, when a vessel nears its destination it is fairly common practice to reduce speed by dragging anchor. Obviously, this can be a potential problem if there are pipelines in the area.

Starting in July 1980, installation requirements were revised by BLM (and now by MMS) for pipelines installed on the Federal OCS in order to mitigate incidents of pipeline failure resulting from the hazards discussed above. For a more detailed description of hazards, see Volume 1, Section IV.C.2.b. of the Final Regional EIS and Section III.A.1.b. of the Regional Environmental Assessment of Pipeline Activities.

In addition to the controls in Sections I.B.3.b.(1)(d) and I.B.4.b., conditions may be attached to permits for rights-of-way should particular concern be warranted. Further, other statements of fact that must accompany Federal permits for OCS pipelines are a certification that the action is consistent with the approved Coastal Zone Management Program of the affected state, and diver verification that the holder has satisfied all permit requirements of the regulations. Additional agencies and a more detailed description of these Federal regulations may be seen in Volume 1, Section IV.C.2.c. of the Final Regional EIS and Sections I.C. and II.C. of the Regional Environmental Assessment of Pipeline Activities.

f. Dredging Activities

Dredging of new channels and maintenance dredging of existing channels is required to provide safe and efficient navigation conditions for commercial and recreational marine transportation. Channel dredging generates significant amounts of dredged material consisting of the sediment and water mixture excavated from areas dredged. On the basis of volume, dredging is the largest single source of material that is ocean dumped. During 1979, more than 72 million cubic yards of dredged material were deposited with the marine environment (U.S. Dept. of the Army, Corps of Engineers, 1980). Of that total, 68% were disposed of in the Gulf of Mexico. The total constituted nearly eight times the combined tonnage of industrial wastes, sewage sludge, construction debris, and other waste material disposed of in the marine environment during 1979 (U.S. Dept. of the Army, Corps of Engineers, 1980). Compared with other materials that are disposed of in the ocean, most of the dredged material excavated in the United States is relatively innocuous, in many instances containing no harmful pollutants and, in most of the remaining cases, containing only trace levels of contaminants. In these cases, the primary concern associated with disposal of the relatively innocuous materials centers around the direct physical effects of disposal. These physical effects include burial of organisms, increased levels of suspended sediments, and accretion of disposed material (U.S. Dept. of the Army, Corps of Engineers, 1978). However, dredged material taken from highly polluted ares is usually contaminated with harmful chemical constituents such as heavy metals, synthetic organics, and oil and grease. Open-ocean disposal of these materials carries the threat of acute or chronic toxic effects on marine organisms and potential contamination of human food resources. Much research has been conducted to describe the effects of dredged material disposal in the marine environment and evaluate disposal of options that may be preferable to ocean dumping.

In general, dredging operations associated with construction projects would result in short-term, localized effects to fish by introducing sediment into the water column and by entraining fish in the suction head of the dredge. This could produce lethal effects through the entrainment or sublethal responses by inhibiting respiration or feeding activities through increased activity.

g. Seismic Operations

Direct, impact-producing agents that are associated with seismic operations are subsurface impulses and the presence of vessel and associated training gear.

Since their beginnings, marine geophysical surveys have caused great concern among commercial fishing and environmental groups. These concerns are that the surveys are lethal, damaging, or disturbing to fish and other marine life and also destructive to commercial fishing gear (crab pots). Because of this, these surveys are regulated by the appropriate State and Federal agencies with jurisdiction in this area. Additionally, there is information that seismic surveys may conflict physically and spatially with commercial fishing.

Shock waves associated with seismic air guns would not immediately be harmful to marine animals (Geraci and St. Aubin, 1980), although noise may affect behavior. Information concerning responses of marine mammals other than cetaceans to seismic and vessel noise is primarily speculative and anecdotal. The principal evidence is provided by Burns and Kelly (1982) who found no significant difference in ringed seal density along seismic control transects. Other information (Dome Petroleum et al., 1982) suggests that while seismic and/or vessel noise might temporarily affect hearing, mask vocalizations or sound used to locate prey or predators, or result in temporary displacement if nearby effects on regional population are likely to be minor negligible.

Whales' reactions to seismic activities vary between immediate response (e.g., flight and startle response) to seemingly no reaction, depending on how close the whales are to an active vessel and what portion of their migration they are in. Behaviors in whales are measured by changes in dive duration, surface duration, number of blows per surfacing, travel direction and speed, calling rate, respiration rate, and other dive characteristics.

h. Trash and Debris

The National Park Service (NPS) and the State of Texas have indicated that debris clearly associated with the petroleum industry (oil drums, large plastic containers and sheeting, computer read-write rings, seismic markers, styrofoam floats, pipe thread protectors, diesel filters, hard hats, and tar balls) is an increasing problem on major recreational beaches in the Western and Central Gulf. Removal, analysis, and disposal of beached 55-gallon drums along South Texas beaches cost the Federal Government upwards of $400,000 in 1985. Over one-half of the 300 drums whose contents were analyzed in 1985 were found to contain hazardous materials, thereby posing potential health and safety threats to beach users. Others in the Central and Western Gulf have also noted the recurring problem of debris wash-up from offshore petroleum operations affecting beach use, aesthetics, and beach maintenance requirements along the Gulf of Mexico shorefront. A special MMS scoping report on beach litter and presentations at the Sixth Annual Gulf of Mexico Information Transfer Meeting (Proceedings . . ., 1985) demonstrated the significance of the beach litter problem Gulfwide and implicated the oil and gas industry as a major contributor in the WPA.

i. Anchoring

Anchors from support boats and ships, floating drilling units, and pipeline laying vessels do a great deal of damage to corals. The area actually affected will depend on depth of water, length of chain, size of anchor and chain, wind, and current. Anchor damage includes crushing and breaking of coral heads. Anchoring often destroys a wide swath of sessile organisms when the anchor is dragged or the vessel swings at the anchor causing the anchor chain to drag the seafloor.

Continental Shelf Associates (CSA) documented the damage caused by a single anchoring incident at the East Flower Garden Bank. The vessel involved was a tug with an attached barge. The predominant area of impact was approximately 3 m wide and 61 m long. Beyond this band, CSA observed intermittent impact in a band extending an additional 122 m. Initially, CSA attempted to count the individual coral colonies impacted; however, they abandoned the count after 200 colonies within 61 m. Mechanical damage to the coral colonies occurred with varying degrees of severity. Slight abrasions of the tissue were widespread. A more severe impact was the complete removal of coral tissue. Finally, the most severe damage resulted from the anchor cable which caused sawing coral heads in half, severing heads from their attachment points, and deep gouges and fractures. Relatively minor impacts can lead to more severe effects due to the introduction of disease or algal infections into the damaged coral tissues. These infestations can lead to mortality of the entire colony (CSA, 1984).

B. OIL SPILLS

1. Historic Spill Rates

Accidental discharge of oil can occur during almost any stage of exploration, development, or production on the OCS. Oil spills occur as a result of many causes, i.e., equipment malfunctions, pipeline breaks, human error, severe storms, etc. Although many oil spills are not directly attributable to the oil extraction process, they are indirectly related through the support activities necessary to recovery and transmission of the resource. Section IV.B.1. of the Final Regional EIS shows that production activity is the major cause of OCS-related oil spills.

The size of an oil spill can vary greatly from less than one barrel to hundreds of thousands of barrels being released over a period of time as a result of a single event. It is not currently known if there is a direct relationship between the size of an oil spill and the event responsible for it. Therefore, the number of oil spills that could occur as a result of the proposals will be shown by size class, rather than source.

Table IV-16 shows the annual number of oil spills on the Federal OCS for various size categories for the years 1964-1983. Sources of these spills include pipeline leaks or breaks, production or exploratory platform mishaps, and one barge accident. The following spill rates were calculated for spill sizes less than 1,000 bbls relative to production rate.

Table IV-16

Number and Volume of Oil Spills (1964-1981) in the Gulf of Mexico Outer Continental Shelf

Year	Less Than One Barrel[1]	1-49 Barrels	50-237 Barrels	238-999 Barrels	Greater Than 1,000 Barrels	Total Spills Greater Than 50 Barrels	Number of Structures	Annual OCS Oil Production (MMB)
1964			0	1/500	4/14,428	5/14,928	1,100	115
1965			0	1/500	1/1,688	2/2,188	1,200	136
1966			0	0	0	0	1,325	175
1967			1/65	0	1/160,639	2/160,704	1,450	206
1968			1/85	0	1/6,000	2/6,085	1,575	250
1969			4/300	2/592	2/10,032	8/10,924	1,675	285
1970			4/428	1/395	2/83,500	7/84,323	1,800	312
1971			10/835	1/450	0	11/1,285	1,891	359
1972			2/150	0	1/4,300	3/4,450	1,935	356
1973			0	1/240	3/21,935	4/22,175	2,001	342
1974	1,051/263	78/404	6/675	0	2/22,046	8/22,721	2,054	316
1975	1,021/255	105/456	2/266	0	0	2/266	2,079	288
1976	881/220	68/303	1/414	1/300	1/4,000	3/4,714	2,096	281
1977	693/173	171/438	2/150	2/550	0	4/700	2,248	250
1978	796/199	96/405	2/239	0	1/1,000[2]	3/1,239	2,327	255
1979	596/149	107/480	4/600	0	1/1,500	5/2,100	2,420	246
1980	607/152	64/359	3/351	1/286	1/1,456	5/2,093	2,555	232
1981	620/155	77/431	3/194	0	1/5,100	4/5,294	2,744	227
1982	1,063/266	106/270	3/542	1/400	0	4/942	2,851	250
1983	1,255/314	113/470	5/591	0	0	5/591	3,005	255*
	8,583/2,146	985/4,016	53/5,885	12/4,213	22/337,624	87/347,722		5,136

[1] Volumes for spills less than one barrel are assumed to be spills of 1/4 barrel each, as no statistics are available.
[2] Spill data from USDI, MMS unpublished Operations Support Pipeline Spill list.

*Preliminary value.

Sources: USDI, GS, 1979-1981.
USDI, MMS, 1983e.

Spill Size	Spill Rate (spills/billion bbls produced)
1-49 bbls	379
50-999 bbls	13

The above spill rates are rounded up to the nearest whole number. Also note that the spill rate for spills less than 1 bbl are not shown due to limitations in the data base.

The 1,000 bbl cutoff between large and small spills was selected primarily for two reasons. First, the smaller spills may occur unnoticed offshore and thus not be included in historic data bases, and second, the large (1,000 bbls and greater) spills projected will be modeled in the Oil Spill Risk Analysis (OSRA) which requires as input, spills large enough to travel great distances or remain intact for up to 30 days time. For these reasons, a slightly different format is used for the spill rates of large spills. Historic spill rates for oil spills greater than or equal to 1,000 bbls on the Federal OCS used in the OSRA (Hannon et al., 1986) as taken from Lanfear and Amstutz (1982) and Nakassis (1982) are as follows:

Spill Rates
1,000 bbls or greater/billion
bbls produced and transported

Platforms	1.00
Pipelines	1.60
Domestic Tankering	1.30 (at sea 0.9/in port 0.4)
Import Tankering	0.65

Import tankering uses one-half the domestic tankering rates because tanker spills are assumed to be distributed evenly along the entire route and only one-half of the import tanker route is assumed to occur in the Gulf.

2. Estimated Mean Number of Spills

The mean spill rates shown in Section IV.B.1. above are applied to the estimated volumes of oil expected to be produced and transported, according to each scenario, in order to project the appropriate mean number of spills estimated to occur from these scenarios. This is accomplished by multiplying the volume of oil against the spill rates. For example, the estimated volume of oil for the M Scenario in the Central Gulf is 0.101 billion bbls; the projected number of spills between 1 and 50 bbls, were calculated by multiplying this volume by 379. For analysis purposes, only whole numbers of spills are discussed so the result is rounded up to the next highest whole value or 39. The following table shows the assumed mean number of small spills for each scenario under the proposed actions.

Assumed Number of Small Spill Occurrences

	Volume of Oil (billion bbls)	1-49 bbls	50-999 bbls
CENTRAL			
L Scenario	0.101	39	2
M Scenario	0.260	99	4
H Scenario	0.470	132	7

WESTERN			
L Scenario	0.040	16	1
M Scenario	0.133	38	2
H Scenario	0.255	97	4

The projected mean numbers of large spills (equal to or greater than 1,000 bbls) are derived in the same manner as the small spills above but, because of the different format of the spill rates and resource breakdowns, the assumed number of spills are presented in a slightly different form. The transportation values, for example, include both spills from pipelines and tankering of OCS products. The assumed number of spills presented in the following table result from rounding up the spill values presented in Table IV-17, as provided by the Branch of Environmental Modeling, MMS, Reston (Anderson et al., 1985).

Assumed Number of Large Spill Occurrences

	Volume of Oil (billion bbls)	Spills from Platforms	Spills from Transportation	Total
CENTRAL				
L Scenario	0.101	1	1	1
M Scenario	0.260	1	1	1
H Scenario	2.470	1	1	2
WESTERN				
L Scenario	0.040	1	1	1
M Scenario	0.133	1	1	1
H Scenario	0.255	1	1	1
TANKERING OF IMPORTS	54.33		25	25

OSRA combines these estimated spills with the results of Gulfwide oil spill trajectory simulations to give the mean number and probabilities of oil spills to occur and contact specified land segments and special targets. The results given indicate the combined risk presented by development and production activities, represented by the platform values above, and by transportation of the oil to onshore facilities. In this analysis, approximately 23% of the oil expected to be produced, under the M Scenarios for both the WPA and CPA, is assumed to be transported by shuttle tanker. Most of this is estimated to occur in deepwater areas outside the existing pipeline network, where pipelaying could be difficult and expensive.

3. Trajectory Simulation

Oil spill trajectory simulations were conducted using seasonal surface currents coupled with wind data, adjusted every three hours for 30 days or until a target is contacted. Hypothetical spill trajectories were simulated for each of the potential launch sites (Visual No. 12) across the entire Gulf. The Eastern Gulf was included, even though there is no proposed action, because of the existing leases and tanker routes which are included in the cumulative analysis. These simulations presume 500 spills occurring in each of the four seasons of the year. The results are presented as probabilities (expressed as percent chance) that an oil spill starting at a particular launch site will contact a certain land segment (Visual No. 12) within 3, 10, or 30 days. A summary of the trajectory analysis (for 10 days) for all launch sites across the Gulf presenting a potential risk to the land segments is given in Table IV-18. This table illustrates that if an oil spill were to occur in the Western Gulf, the probability (expressed as percent chance) of contact with a certain land segment within 10 days from less than 0.5% to about 65%. The corresponding counties for the highest percent chance of contact are Matagorda County in Texas and Plaquemines Parish in Louisiana.

Table IV-17

Oil Spill Probability Estimates for Spills Greater than 1,000 Barrels Resulting over the Expected Production Life of Future OCS Lease Sales; from Existing Federal Leases; and from Transporting Crude Oil Imports by Tanker in the Study Area

Source	Volume (bbls)	Mean Number of Spills from Platforms	Mean Number of Spills from Transportation	Mean Number of Spills (total)	Probability of One or More Spills (platforms)	Probability of One or More Spills (transportation)	Probability of One or More Spills (total)
Proposed Action							
Most Likely Find Scenario							
Western Gulf	(0.13)	0.13	0.18	0.31	0.12	0.16	0.27
Central Gulf	(0.26)	0.26	0.38	0.64	0.23	0.32	0.47
Low Find Scenario							
Western Gulf	(0.04)	0.04	0.06	0.10	0.04	0.06	0.10
Central Gulf	(0.10)	0.10	0.15	0.25	0.10	0.14	0.22
High Find Scenario							
Western Gulf	(0.26)	0.26	0.36	0.62	0.23	0.30	0.46
Central Gulf	(0.47)	0.47	0.69	1.16	0.37	0.50	0.69
Prior and Future Sales							
Western Gulf	(0.97)	0.97	1.39	2.36	0.62	0.75	0.91
Central Gulf	(5.94)	5.94	9.15	15.09	0.99+	0.99+	0.99+
Eastern Gulf	(0.18)	0.18	0.44	0.62	0.16	0.36	0.46
Tankering of Crude Oil Imports							
All Planning Areas	(54.33)	–	24.45	24.45	–	0.99+	0.99+

Source: Hannon et al., 1986.

Table IV-18

Trajectory Simulation[1]

Probabilities (expressed as percent chance) that an Oil Spill Starting at a Particular Location will Contact a Certain Land Area within 10 Days

Hypotehtical Spill Location

Land Segment	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W14	W15	W16	W17	W21	W22	W23	W24
1	35	3	1	18	5			2											
2	18	6	1	9	5			1	1										
3	27	60	13	16	29	3	1	2	2										
4	2	24	24	2	21	5	1	1	2										
5		3	38		11	12	5	2	8										
6			16		2	19	17	1	12	2		2	1						
7			2		1	24	53		10	16	5	4	7	1					
8						4	15		1	46	71	1	8	23	10	1	1		
9											7			16	32		6	5	2
10														2	37		7	49	43
11																		5	39
12																			1

Hypothetical Spill Location

Land Segment	W29	W30	C31	C32	C33	C38	C39	C40	C41	C42	C47	C48	C49
10	3	20	1	5	4								
11	1	14	1	18	18		1	2					
12		1	1	20	63	1	23	62	13	10		1	1
13							1	9	19	61	1	8	13
14									1	4	1	6	20
15												1	2
16											2	10	23

Hypothetical Spill Location

Land Segment	C53	C54	C55	C56	C59	C60	C61	C62	C63	C64	C67	C68	C69	C70	C71	C72	C73	C74	C75
16	1	15	40	29			2	4	1										
17		4	12	39		2	8	23	13	1									
18				14			4	20	41	4									
19					2	8	19	14	30	65	1	5	7	18	20	4	1	1	2
20										2			1	11	43	32		4	11
21															1	8		3	17
22																1		4	7

Hypothetical Spill Location

Land Segment	C76	C77	E84	E85	E86	E93	E94	E95
19	1							
20	5	6						
21	21	35		1				
22	25	39	3	10	6			
23	3	9	3	21	36		1	1
24			2	13	34	1	14	22
25						1	11	30
26							4	12
27							1	2

Table IV-18. Trajectory Simulation[1] (continued)

	Hypothetical Spill Location				
Land Segment	E105	E106	E116	E117	E118
25		3			
26	1	10			
27	3	17			
28	5	3		3	
29	4	1	3	36	61
30				1	20

	Hypothetical Spill Location										
Land Segment	E128	E129	E130	E137	E138	E140	E141	E146	E147	E150	E151
29	1	12	19								
30		7	43								
31		1	8								
32		1				1					
33						4					
37					2						
38				1				1			
39				1				2			
41										1	1
42										1	1
43							2		17		

[1] Columns and rows with values less than 0.5% are not shown.

Source : Hannon et al., 1986.

Note: Refer to Visual No. 12 for a description of land segments and hypothetical spill areas when using this table.

4. Estimated Number of Oil Spills Occurring and Contacting Sensitive Resources

The final phase of the OSRA combines the projected mean number of spill occurrences with the probabilities of contact provided by the trajectory analyses. The results are given in a series of tables presenting two values for each land segment and special target across the Gulf, in each of three time frames; 3, 10, and 30 days. The two values represent the probability of one or more spills to occur and contact the target, and the estimated mean number of spills that might occur and contact the target. Tables IV-19 and IV-20 are subsets of these tables showing only those land segments and special targets considered most at risk to contact by an oil spill resulting from development, production, or transportaiton Gulfwide. For each planning area the appropriate table shows the risk from several sources of oil, both from within and from outside the planning area. These include the proposed volume expected to be discovered and produced as a result of this sale, the M Scenario, plus a Low and a High volume for the proposal. Estimates for volumes of oil expected to be produced as a result of prior sales in this planning area, as well as for future sales currently scheduled in the Five-Year Programmatic, are added to the M Scenario volume to indicate the risk presented by all OCS activities within the planning area. This Total Planning Area (TPA) volume is combined with other TPA's and imports of foreign crude into the Gulf to indicate the risk of oil spills from all activities--the Aggregate--on the Federal OCS.

Section IV.A.4. states the assumptions made regarding the values in Table IV-19 and IV-20, which will allow the analytical discussions in Section IV.D. to address only whole number representations for the mean number of spills estimated to occur and contact individual land segments and special targets.

5. Chronic or Long-term Oil Pollution

a. Sources of Hydrocarbon Inputs into the Gulf of Mexico

Sources which contribute as hydrocarbon inputs into the Gulf of Mexico include natural seeps, accidental spills, and long-term, low-level discharges. The presence of hydrocarbons in the marine environment is, to some extent, unavoidable. Those hydrocarbons found in the world's oceans are generated by both natural, biological, and geochemical processes, and anthropogenic inputs. The majority of these hydrocarbons are introduced into the sea as a result of man's activities: coastal refining; industrial waste disposal; urban and river runoff; transportation losses; and offshore oil and gas activities.

Figure IV-3 illustrates the probable amounts of hydrocarbons which annually enter into the Gulf of Mexico OCS from the major offshore, coastal, and land-based sources. The Mississippi River discharge completely dominates petroleum loadings of Gulf waters (78.3%) with offshore domestic oil exploration and production activities adding only 0.6% annually to the petroleum entering the Gulf. Maritime transportation activities release an estimated 4.8%, with the majority of this coming from operational discharges of tankers. Natural seepage is the second largest contributor of petroleum to Gulf waters. For a more detailed discussion of this subject, see Table IV-26 and Appendix E of the Final Regional EIS.

The OCS spill rates for spills greater than or equal to 1,000 bbls (major spill events) occurring are:

From Platforms	1.0 spill incidents per billion bbls produced
From Pipelines	1.6 spill incidents per billion bbls transported

The OCS spill rate for spills between 1 bbl and 999 bbls, from either pipeline or platform, is 379 spills per billion bbls produced or transported.

The vast majority of spills are small (99% were less than 50 bbls and 89% were less than 1 bbl). The volume of oil spilled from these small spills is insignificant compared to production (2.3 bbls spilled per million barrels produced).

b. Sublethal and Long-term Effects of Chronic or Low-level Oil Pollution

The sublethal effects on marine organisms resulting from low-level chronic oil discharges and small spills may prove to be the most harmful impact to the marine ecosystem in areas exposed to long-term oil exploration activities.

Table IV-19

Oil Spill Risk Analysis, Central: Estimates of Oil Spills (1,000 bbls or greater) Occurring and Contacting Land Segments and Special Targets within 10 Days

Land Segment/ Special Target	L Scenario		M Scenario[1] (Proposed)		H Scenario		Prior Sales[2]		Future Sales[3]		Total Planning Area[4]		Total Other Planning Areas		Imports		Aggregate[5]	
	prob	mean	prob	mean	prob	mean	prob	mean	prob	mean	prob	mean	prob	mean	prob	mean	prob	mean
1 - Cameron, TX													1	0.0			1	0.0
2 - Willacy, TX													2	0.0			2	0.0
3 - Kenedy, TX													12	0.1			13	0.1
4 - Kleberg, TX													8	0.1	1	0.0	9	0.1
5 - Nueces, TX et al.													12	0.1	4	0.0	15	0.2
6 - Aransas, TX													3	0.0	7	0.1	10	0.1
7 - Calhoun, TX													3	0.0	4	0.0	7	0.1
8 - Matagorda, TX													9	0.1	3	0.0	11	0.1
9 - Brazoria, TX													19	0.2	8	0.1	26	0.3
10 - Galveston, TX et al.							2	0.0			3	0.0	43	0.6	23	0.3	57	0.9
11 - Jefferson, TX							6	0.1			7	0.1	3	0.0	17	0.2	24	0.3
12 - Cameron, LA	1	0.0	2	0.0	4	0.0	47	0.6	7	0.1	52	0.7	1	0.0	14	0.1	59	0.9
13 - Vermilion, LA	2	0.0	4	0.0	8	0.1	50	0.7	12	0.1	58	0.9					58	0.9
14 - New Iberia, LA	1	0.0	3	0.0	6	0.1	38	0.5	6	0.1	44	0.6					44	0.6
15 - St. Mary, LA					1	0.0	4	0.0	1	0.0	5	0.0					5	0.0
16 - Terrebonne, LA	4	0.0	9	0.1	16	0.2	74	1.3	18	0.2	80	1.6			16	0.2	83	1.8
17 - Lafourche, LA	1	0.0	2	0.0	3	0.0	53	0.8	10	0.1	59	0.9			39	0.5	75	1.4
18 - Jefferson, LA			1	0.0	1	0.0	37	0.5	5	0.0	40	0.5			8	0.1	45	0.6
19 - Plaquemines, LA	2	0.0	5	0.1	10	0.1	85	1.9	15	0.2	88	2.1	1	0.0	9	0.1	89	2.3
20 - St. Bernard, LA et al.	1	0.0	2	0.0	4	0.0	50	0.7	5	0.1	54	0.8	1	0.0	1	0.0	55	0.8
21 - Hancock, MS et al.					1	0.0	6	0.1			6	0.1	1	0.0	14	0.2	20	0.2
22 - Mobile, AL							2	0.0			2	0.0	2	0.0	8	0.1	12	0.1
23 - Baldwin, AL													3	0.0	1	0.0	4	0.0
24 - Escambia, FL et al.													4	0.0			4	0.0
28 - Gulf, FL													1	0.0			1	0.0
38 - Manatee, FL													1	0.0			1	0.0
Land	12	0.1	27	0.3	44	0.6	99+	7.4	58	0.9	99+	8.5	78	1.5	87	2.0	99+	12.1
Archaeological Sites	1	0.0	2	0.0	3	0.0	43	0.6	6	0.1	48	0.6	38	0.5	35	0.4	79	1.6
Brown Pelican Habs.	2	0.0	5	0.1	9	0.1	77	1.5	19	0.2	82	1.7	26	0.3	27	0.3	90	2.3
W. I. Manatee Habs.													2	0.0			2	0.0
Sea Turtle Nesting													38	0.5	6	0.1	42	0.5
TX Recr. Beaches							2	0.0			2	0.0	67	1.1	25	0.3	76	1.4
LA Recr. Beaches	1	0.0	3	0.0	5	0.0	73	1.3	14	0.1	78	1.5	2	0.0	51	0.7	89	2.2
MS Recr. Beaches					1	0.0	7	0.1			7	0.1	1	0.0	18	0.2	25	0.3
AL Recr. Beaches							2	0.0			2	0.0	5	0.1	4	0.0	11	0.1
FL Recr. Beaches													6	0.1			7	0.1
LA Env. Pres. Areas	1	0.0	2	0.0	3	0.0	23	0.3	4	0.0	28	0.3					28	0.3
MS Env. Pres. Areas	1	0.0	2	0.0	4	0.0	51	0.7	5	0.1	55	0.8	2	0.0	21	0.2	65	1.0
AL Env. Pres. Areas													4	0.0			4	0.0
FL Env. Pres. Areas													4	0.0			4	0.0

Table IV-19. Oil Spill Risk Analysis, Central: Estimates of Oil Spills (1,000 bbls or greater) Occurring and Contacting Land Segments and Special Targets within 10 Days (continued)

Land Segment/ Special Target	L Scenario		M Scenario[1] (Proposed)		H Scenario		Prior Sales[2]		Future Sales[3]		Total Planning Area[4]		Total Other Planning Areas		Imports		Aggregate[5]	
	prob	mean	prob	mean	prob	mean	prob	mean	prob	mean	prob	mean	prob	mean	prob	mean	prob	mean
Vermilion/Atch. Bays	2	0.0	5	0.1	9	0.1	50	0.7	8	0.1	56	0.8					57	0.8
Timbalier Bay			1	0.0	2	0.0	36	0.4	7	0.1	41	0.5			25	0.3	55	0.8
Barataria Bay	1	0.0	1	0.0	2	0.0	54	0.8	7	0.1	58	0.9			8	0.1	61	1.0
Breton/Chand. Sounds							6	0.1	1	0.0	7	0.1			1	0.0	8	0.1
Mississippi Sound							1	0.0			2	0.0			3	0.0	4	0.1
FL Bay Fish. Area													5	0.1			5	0.1
TX End. Species													52	0.7	24	0.3	64	1.0
LA End. Species	4	0.0	9	0.1	16	0.2	98	3.8	31	0.4	99	4.3	2	0.0	50	0.7	99	5.0
MS End. Species					1	0.0	6	0.1			6	0.1	1	0.0	14	0.2	20	0.2
FL End. Species													7	0.1			7	0.1
Padre Island N.S.													21	0.2	1	0.0	22	0.3
Gulf Island N.S			1	0.0	1	0.0	7	0.1			8	0.1	2	0.0	22	0.2	30	0.4
LA Mangroves	5	0.0	12	0.1	21	0.2	94	2.8	30	0.4	96	3.3	1	0.0	50	0.7	98	4.0
TX Marshes					1	0.0	9	0.1			9	0.1	59	0.9	43	0.6	79	1.5
LA Marshes	11	0.1	26	0.3	42	0.5	99+	7.0	56	0.8	99+	8.1	4	0.0	64	1.0	99+	9.2
MS Marshes					1	0.0	6	0.1			6	0.1	1	0.0	14	0.2	20	0.2
AL Marshes							2	0.0			2	0.0	4	0.0	9	0.1	15	0.2
TX Seagrass Beds							2	0.0			3	0.0	43	0.6	23	0.3	57	0.9
LA Seagrass Beds	5	0.1	13	0.1	22	0.2	94	2.8	30	0.4	96	3.3	1	0.0	50	0.7	98	4.0
MS Seagrass Beds					1	0.0	6	0.1			6	0.1	1	0.0	14	0.2	20	0.2
AL Seagrass Beds							2	0.0			2	0.0	2	0.0	8	0.1	12	0.1
FL Seagrass Beds													1	0.0			1	0.0
Galveston Bay							2	0.0			3	0.0	43	0.6	23	0.3	57	0.9
Mobile Bay							2	0.0			2	0.0	4	0.0	9	0.1	15	0.2
Tampa Bay													1	0.0			1	0.0

Note: Prob - indicates the probability (expressed as percent chance) of one or more spills occurring and contacting a land segment or special target.
Mean - is the mean number of spills estimated to occur and contact a land segment or target.
Land segments and special targets with a probability value less than 0.5% and a mean of 0.0 are not listed in this table.

[1] Represents the Most Likely Find Scenario volume of undiscovered economically recoverable oil for Sale 110.

[2] Represents the volume of oil expected to be produced by activities resulting from all sales in the Central Gulf prior to Sale 110.

[3] Represents the volume of oil estimated to be produced by activities resulting from all remaining Central Gulf sales scheduled in the five-year program after Sale 110.

[4] Represents the volume of oil equal to the sum of the M Scenario plus prior sales and future sales for the Central Gulf.

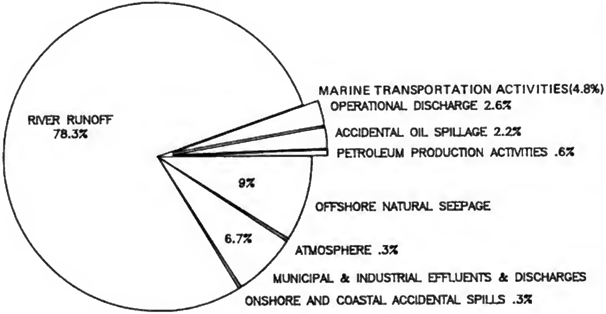
[5] Represents the volume of oil equal to the Total Planning Area volume for the Central Gulf plus the total Western and Eastern Planning Areas and Gulfwide imports.

Source: Hannon et al., 1986.

SOURCES OF PETROLEUM INPUTS INTO THE GULF OF MEXICO OUTER CONTINENTAL SHELF WATERS

TOTAL PETROLEUM INPUTS

Offshore	14.4%
Onshore	85.3%
Atmosphere	0.3%



ANNUAL PERCENTAGE

SOURCE: MMS, GULF OF MEXICO REGION ESTIMATES, 1982.

Figure IV-3

Little is known about low concentration oil pollution and there exists too small a consensus to support any definitive assessment at present. It is not known if petroleum introduction into the marine environment is causing significant deleterious and chronic effects, and even more important, if this contamination is producing a long-term significant alteration of the marine environment.

Sublethal effects are defined as those that impair the ability of an organism to function effectively without causing direct mortality, although these effects can be directly lethal. Usually sublethal and/or long-term effects are associated with low concentrations of petroleum which may be present in the marine environment due to chronic low-level oil discharges and small spills (less than 1,000 bbls) or from large spills in which evaporation, degradation, and dispersion of the spilled hydrocarbons ultimately result in the formation of sublethal concentrations.

Low-level chronic oil pollution may have more long-term harmful consequences to the ecosystem than the isolated large spills (i.e., spills greater than or equal to 1,000 bbls) which the public, as a whole, fears the most. The issue over the effect of low-level oil contamination versus catastrophic spills seems to be supported from both sides.

Accumulation of petroleum hydrocarbons from crude oil by organisms in areas of chronic petroleum contamination is well-documented both in the field and the laboratory, much more so than the effects of these sublethal quantities (Milan and Whelan, 1978; Ehrhardt, 1972). More work is needed on a systematic study of the uptake and the response of petroleum by an ecosystem.

There are several routes via which hydrocarbons enter the marine food web. Uptake processes include: (1) adsorption onto particles by living and dead matter, followed by ingestion of these particles; (2) active uptake of dissolved or dispersed petroleum; and (3) passage into the gut of fish which gulp or drink water. Uptake into body tissues may occur through respiratory surfaces, gastrointestinal tract, and external surfaces.

Sublethal levels of petroleum accumulation by the aquatic environment may interfere in the normal physiological processes and behavioral responses of marine organisms. Sublethal effects can include: (1) disruption of normal behavior-finding, breeding, and locomotion; (2) interference with thermo-regulation; (3) interference with the ability to locate food and avoid predators; (4) disruption of homing behavior; and (5) interference with the ability to locate mates or other sexual stimuli; all of which are necessary for the propogation and survival of marine species. Other harmful indirect effects include: (6) destruction of food sources; (7) synergistic effects that reduce resistance to other stresses; and (8) incorporation of carcinogenic and potential metagenic chemicals.

There are serious limitations in understanding ecological effects of sublethal concentrations of petroleum hydrocarbons in aquatic ecosystems. A basis for developing such an understanding must be an understanding of the processes operating in the Gulf ecosystem in its natural state. Such an understanding is not available now. The Gulf marine ecosystem is already burdened by pollution from other chemical compounds such as pesticides. The assimilative capacity for petroleum loading should be determined. The timeframe and the concentrations that a system must be exposed to have irreparable damage is presently unknown.

The MMS Environmental Studies Program is striving to place more emphasis on assessing the environmental and ecological long-term impacts from OCS oil and gas development. The Washington Office Branch of Environmental Studies is developing a program plan for the design of studies to assess long-term impacts. This program is being coordinated with the Interagency Committee on Ocean Pollution Research, Development, and Monitoring (COPRDM). Recently, a study edited by D.F. Boesch and N.N. Rabalais entitled, "The Long-term Effects of Offshore Oil and Gas Development: An Assessment and a Research Strategy" (June 1985), has been completed. Nine categories of potential long-term environmental effects for future investigation were identified as follows: (1) chronic biological effects resulting from the persistence of medium and high molecular weight aromatic hydrocarbons and heterocyclics and their degradation products in sediments and cold environments; (2) the residual damage from oil spills to biogenically structured communities, such as coastal wetlands, reefs, and vegetation beds; (3) effects of channelization for pipeline routing and navigation in coastal wetlands; (4) effects of physical fouling by oil of aggregation of birds, mammals, and turtles; (5) effects on benthos of drilling discharges accumulated through field development rather than from exploratory drilling; (6) effects of produced water discharges into nearshore rather than open shelf environments; (7) effects of noise and other physical disturbance on populations of birds, mammals, and turtles; (8) the reduction of fishery stocks due to mortality of eggs and larvae as a result of oil spills; and (9) effects of artificial islands and causeways in the Arctic on benthos and anadromous fish species.

The National Academy of Sciences has released an update of its 1975 review which summarizes what is known about petroleum in the marine environment. The review is entitled, "Oil in the Sea: Inputs, Fates, and Effects" (NAS, 1985). One of the conclusions with regard to long-term, chronic effects of oil was that there is no clear indication that commercial fish stocks have been severely disrupted. Another conclusion was that the synergistic impact of chronic oil pollution with other contaminants in waters near industrialized or heavily populated coastal regions is poorly understood and requires further research.

6. Assumptions about the Characteristics, Fates, and Effects of a Typical Oil Spill Occurring from OCS Oil Development Activities

Volume 1, Section IV.B.3. of the Final Regional EIS discusses assumptions on the fates and effects of a typical Gulf oil spill occurring in connection with OCS oil exploration and production activities. Conclusions reached are summarized here. Spilled Louisiana crude disperses and degrades rapidly due to the influences of the Gulf's warm climatic conditions and the properties of the oil. Within a few days the spilled oil has disappeared. By modeling the mass balance of a typical Gulf oil spill, it is shown that the natural weathering and degradation processes will remove nearly all of the original volume of spilled Louisiana light crude within 30 days. Louisiana crude and some other northern Gulf Coast crudes do not form tar balls (Jeffrey et al., 1974). Based on limited data on Gulf Coast oil spillage, concentrations of spilled petroleum that reach nearshore sediments degrade to background levels within 1-2 years. No known significant harmful, short-term effects on Gulf coastal or open water environments have been identified from oil spills from OCS oil and gas development scenarios.

a. Characteristics

It is assumed that spills occurring due to the proposed actions will have characteristics similar to Louisiana crude (a light, very low asphaltene oil), although variations in composition can be expected from oils produced from different formations or fields within each region or between areas. Properties of south Louisiana crude are presented in Volume 1, Section IV.B.3.a. of the Final Regional EIS.

In order to study the fate of a typical oil spill, an average size spill was determined based on major historic oil spills greater than or equal to 1,000 bbls. The average size is 17,222 bbls. Due to few extremely large spills, however, the most likely size spill is around 2,000 bbls. Assumptions made in this document about any chemical and physical alterations to the spilled oil is based on the average size spill.

b. Fates

A variety of processes occur when oil is spilled on water, altering its chemical and physical characteristics. Collectively, these are referred to as weathering or aging of the oil and will determine, to a large degree, its fate. Spilled Louisiana crude disperses and degrades rapidly due to the influences of the Gulf's warm climatic conditions and the properties of the oil. Times for the dominant effects of the weathering processes (a mass balance) are shown in Table IV-20 of the Final Regional EIS, as well as the percent volume loss from the slick from the sea surface after 10 and 30 days.

Ten days is chosen as the most likely oil slick sea surface residence time, and the Oil Spill Risk Analysis Model focuses on the 10-day time frame. After 10 days, the oil properties have changed extensively. The original volume has decreased greatly; 47%-67% of the original slick volume is lost from the water's surface. The floating oil is largely devoid of its volatile (acutely toxic) components and is gradually forming emulsions. By four days, enlargement of the slick is complete, and actual spreading is subordinate to fragmentation and dispersion (Wheeler, 1978).

Section IV.B.3.b. of the Final Regional EIS discusses the major pathways through which a Gulf of Mexico oil slick is weathered. Dominant processes affecting spilled oil during 10 days or less include spreading, evaporation, dissolution, and dispersion. Dominant processes altering a slick's characteristics after 10 days include emulsion formation, sedimentation, auto- and photo-oxidation, biological processes, and tar residue formation (Jordan and Payne, 1980).

The ultimate fate of environmentally dispersed petroleum in open waters is poorly understood. Only 2% of the oil spilled from the IXTOC blowout was ever accounted for, either found on beaches or residing offshore in tar mats. However, information about the ultimate fate of one Gulf spill shows rapid loss. Spilled oil from the 1970 Chevron Main Pass Block 41 blowout, identified in nearshore sediments, showed rapid weathering after one week to one month and at the end of one year was reduced to a few percent of the amount in the sediments found immediately after the spill impact. Further discussion of this subject is included in Section IV.B.3.b. of the Final Regional EIS.

Concern about oil spillage from underwater pipelines or subsurface blowouts associated with the oil industry activities offshore and acquired scientific information and studies on such phenomena have resulted in an addition to our summary of the fate of spilled oil. The following summary is based mainly on the results of a large effort undertaken by the research teams studying the IXTOC blowout (Payne et al., 1980a; Fiest and Boehm, 1980; Payne et al., 1980b; Boehm and Fiest, 1980a; Boehm and Fiest, 1980b; and Walter and Proni, 1980). The PEMEX IXTOC subsurface blowout occurred on June 9, 1979, in Mexican offshore water, spilling approximately 10,000 bbls a day until capped in March 1980. This provided the scientific community the first major opportunity to focus studies on the subsurface transport processes affecting spilled petroleum.

Oil in the Water Column

When initially spilled, most crude oils float. However, some of the spilled oil is found dispersed and retained in the water column. The mechanisms which result in oil being retained in the water column include: dissolution, dispersion, sinking, and sedimentation. By studying the IXTOC blowout, a little-known mechanism, subsurface plume formation, which results in higher concentrations of oil distributed in the water column than the other processes, was better understood. These processes are summarized in this section after the following general discussion on the amount of oil that is expected to be measured in the water column.

About 1%-5% of the volume of the surface slick is predicted to occur in the water column in the vicinity of the spill. Some of this oil will reach bottom sediments (MacKay et al., 1979; Rhode Island, University of and Applied Science Associates, 1981; and Boehm and Fiest, 1980b). The relative amount of oil which resides in the water column is a function of a number of factors, including the chemical and physical nature of the oil, the point of release (surface versus subsurface), and the hydrographic conditions affecting the slick formed, particularly the sea surface turbulence. The location of subsurface oil is governed by the density stratification of the water column. The submerged oil exists in association with strong water temperature and salinity gradients.

Fiest and Boehm (1980) reviewed the literature reporting concentrations of oil in water and found that the average reported concentrations generally were: less than 1 ug/l for pristine areas; 2-100 ug/l under spills occurring in nearshore areas; and 100-800 ug/l in heavily polluted urban environments. General background values for the Gulf of Mexico were from nondetected to 70 ug/l. The higher value indicates a chronic paraffinic oil intrusion.

The concentrations of oil in the water column measured around the site of the IXTOC blowout ranged from values of less than 5 ug/l at a distance of 80 km from the blowout to peak values of 10,600 ug/l within a few hundred meters of the wellhead. The highest concentrations were observed within 25 km of the blowout in the top 6 m of the water column (Fiest and Boehm, 1980). Fiest and Boehm (1980) compared these IXTOC results to other major spills and, except for the very high concentrations found beneath the surface slick which will be discussed later, found that values measured at the outside edge of the oil plume were similar (Ekofisk blowout, 2-300 ug/l; *Amoco Cadiz*, 350 ug/l; and *Argo Merchant*, 450 ug/l) to the maximum values measured during the other major spills.

The important mechanisms which occur that result in such concentrations of oil being retained in the water column are discussed below:

> Dissolution: Lower molecular weight hydrocarbons, in particular aromatics such as benzene and toluene that are acutely toxic, will rapidly dissolve into the water column once oil is spilled.
>
> Dispersion: The agitation of oil slicks due to the breaking of waves and the action of the surf supplies the energy to form small droplets of stable emulsions from 5 micrometers to several millimeters in size. Such droplets are then pushed into the water column and dispersed. Dispersion of a surface slick is an important process in determining the lifetime of the slick. The formation of droplets increases the surface area of the oil, thereby increasing the rates of physical, chemical, and biological processes affecting the weathering of the oil.
>
> Sinking: Whole oil particles in the form of mousse or tar could become heavier than the surrounding water and sink until encountering an interface strong enough to inhibit penetration (Walter and Proni, 1980).

Sedimentation: This process is characterized by oil associating with particulate material in the water column. It is already described in some detail in Volume I, Section IV.B.3.b. of the Final Regional EIS. In the case of the IXTOC blowout, in several instances, particulate-bound oil was found where surface slicks were not readily apparent (Payne et al., 1980b). To explain this, it was hypothesized that once oil had been adsorbed onto particulates, it was then subject to subsurface horizontal and vertical advective transport and could be transported a considerable distance before settling to the bottom. Payne et al. (1980b) reviewed the literature on particulate/oil interactions and concluded that these interactions are a dominant process in the ultimate disposition of petroleum.

Subsurface Plume Formation: Fiest and Boehm (1980), Walter and Proni (1980), and others examining the characteristics of the IXTOC blowout determined that a significant quantity of the oil released at the subsurface from the wellhead formed a subsurface plume of oil droplets suspended in a mixed layer at a depth of 5-20 m. The oiled seawater plume moved in response to ocean currents rather than the wind. An oceanic frontal system may have acted as a barrier to the lateral transport of the oil plume and may also have acted as a conduit for the subsurface movement of oil along the frontal axis. Within 5 km from the wellhead, the subsurface plume was made up of oil droplets > 0.45 um and had petroleum hydrocarbon concentrations > 600 ug/l. Such whole oil was found at concentrations > 20 ug/l at 20 m depths within 25 km from the well (Fiest and Boehm, 1980). Although there appeared to be other processes not identified controlling the transport of the subsurface plume for those controlling the movement of the surface slick, the subsurface plume was, for the most part, aligned with the surface slick.

Water samples taken from this subsurface plume were considerably enriched in light aromatics relative to other aromatic components, presumably due to the presence of considerable quantities of soluble, solubilized, or colloidal material in the water. The fact that the subsurface oil can be characterized by a different chemistry and weathering regime implies that the subsurface oil is a "fresh" oil plume which has remained subsurface since its discharge, and in which evaporative loss of aromatics is greatly decreased (Boehm and Fiest, 1980b).

Of particular importance is the fact that concentrations of some of the more toxic components appeared in the water column in sizeable amounts. The concentrations of individual hydrocarbons in the dissolved fraction (0.01-3 ppb) measured in a study by Boehm and Fiest (1980b) appeared to lie below the toxic range, even in the acute impact zone. However, the total concentration of waterborne low molecular weight aromatics (alkyl benzenes and naphthalene compounds) in water fell in the 0.5-500 ppb range, and concentrations of total waterborne oil dispersion were in the 100-10,000 ppb (0.10-10 ppm) range. The researchers report that these values fall well within the range causing observable effects on marine organisms.

Photooxidation

Evidence of photooxidation was reported during the IXTOC I spill and confirmed in the laboratory. Atwood and Ferguson (1982) observed light brown emulsified oil darken and form black streaks. They assumed that this was the result of photooxidation. Mackay et al. (1981a and b) and Boehm and Fiest (1980b) reported that photooxidation produced significant changes in the oil at distances greater than 50 km from the wellhead. Overton et al. (1980) exposed fresh IXTOC oil in synthetic seawater to natural sunlight and observed the conversion of the oil to a crusted material which broke up into tarry flakes. Patton et al. (1981) reported pancakes and flakes at a distance of 750-1,000 km from the wellhead.

The recent update of the National Academy of Sciences' 1975 report on petroleum in the marine environment entitled, "Oil in the Sea: Inputs, Fates, and Effects" (NAS, 1985), contains some advances in our knowledge of fates of oil. Evaporation has been found to account for one- to two-thirds of oil spill weathering and occurs over a period of a few hours to a day after the spill (Jordan and Payne, 1980). Almost all of the evaporated oil is photochemically oxidized. Dissolution into the water column is much less important because the few soluble components of oil are lost immediately by evaporation. Microbial degradation has been discovered to be significant and currently, rates are being determined.

c. Effects of Oil Spillage

The majority of oil spills that have occurred in connection with oil industry operations in the Gulf have probably resulted in no serious short-term deleterious effects. This conclusion is based on the sparse documentation available on the historic effects of oil spills on the Gulf shoreline and on the rapidity with which Louisiana crude disperses and degrades.

Each spill is a unique event, with a number of factors interacting to determine its effects, and all spills occurring in the Gulf could be potentially harmful. The variability encountered in the literature on environmental effects of oil spills is due to differences in oil components, environmental conditions, and the organisms encountered. The most damage from an oil spill would occur when a spill from the open ocean reaches a confined shallow body of water where waterfowl or marine organisms are concentrated.

Although unanswered questions will remain on the subject of oil impact for many years to come, some general conclusions about the effects of oil spills are widely accepted.

(1) Short-term effects of spilled oil in the marine environment are usually not catastrophic. The environment eventually recovers if the stress is removed or reduced significantly. Oil reaching some coastal areas, however, may render areas uninhabitable to plants and animals, particularly in marsh and shallow estuarine environments where long-term ecosystem alteration could result.

Studies by O'Neil et al. (1983) indicate effects of petroleum spills on marsh flora varies. Salt grass was reported killed by repeated application of crude oil during a 5-month interval (Wilson and Hunt, 1975). Recovery time of cordgrass (*Spartina*) from a crude oil spill was estimated at 1-3 years (Krebs and Tanner, 1981). Holt et al. (1978) reported the effects of a small (377 bbls) crude oil pipeline spill at Harbor Island near Aransas, Texas. The oil spilled into a cordgrass (*Spartina*) and black mangrove marsh. The long-term effects of the oil spill were minimal in most of the affected areas. Through the first growing season, cordgrass growth was much reduced in areas with heavy concentrations of oil compared to more lightly affected areas. Results indicated that heavy oiling at the end of the growing season was manifested in the next growing season, and heavy oiling of cordgrass in any season is apparently lethal. The black mangrove appeared relatively tolerant to even heavy oiling.

(2) Birds which spend much time on the sea surface (e.g., shearwaters, cormorants, seaducks, and alcids) are especially vulnerable to oil spills (King and Sanger, 1979). Mortality results primarily from hypothermia (excessive heat loss) as oil mats the plumage destroying the thermal barrier (air trapped beneath the feathers). Direct contact by birds with oil of appreciable amounts is usually fatal.

Abnormalities in bird reproductive physiology and behavior resulting from ingestion of oil (Hartung and Hunt, 1966; Stickel and Dieter, 1979; Ainley et al., 1981; Holmes, 1984; Peakall et al., 1981; and Gorsline and Holmes, 1982) potentially could have substantial adverse effects on egg production in seabird and waterfowl populations. In addition, transfer of oil from adults to eggs results in reduced hatchability, increased incidence of deformities, and reduced growth rates in young (Grau et al., 1977; Albers, 1978; and Szaro et al., 1978). Holmes et al. (1978) have shown that stress from ingested oil can be additive to ordinary environmental stress (e.g., low temperature). Presumably, the effects of external oiling would also be more severe when birds are under environmental stress (e.g., winter) or physiological stress (e.g., molting).

(3) Benthic communities appear to be the most vulnerable to oil spills (Byrne and Calder, 1977; Tatem et al., 1978; and NAS, 1975 and 1985). Benthic organisms can become coated with heavy oil and smothered. Filter feeders and detritivore ingest oil associated with their food. Recent field studies suggest less ecological damage than investigators earlier thought to benthos associated with offshore oil installations, oil spills, or natural marine oil seepage (Middleditch and Basile, 1980; ERCO, 1982; Ward et al., 1980; and Davis and Spies, 1980).

(4) Adult pelagic fish are, for the most part, able to avoid spilled floating oil in open water areas by swimming away from the affected region. However, other stages of the fish life cycle are more susceptible to acute biological loss. Fish eggs and larvae are vulnerable to oil damage in the open water environment as they float along. Spills reaching nearshore bays, and spawning or breeding grounds, could cause serious detrimental effects (NAS, 1975). However, there is no evidence that commercially important fish stocks have been significantly affected by spills or chronic oil pollution. The effects may be masked by natural fluctuations in populations and our present, crude stock assessment methods (NAS, 1985).

According to Evans and Rice (1974), the impacts on fishery resources from oil pollution are: (a) killing organisms through coating and asphyxiation; (b) killing organisms through contact poisoning; (c) killing organisms through exposure to water soluble toxic components of oil at some distance in time and space from the accident; (d) destroying the generally more sensitive juvenile organisms; (e) destroying sources of food and shelter; (f) incorporating sublethal amounts of oil and oil products into organisms (resulting in reduced resistance to infection and other stresses); (g) incorporating carcinogenic and potentially mutagenic chemicals into marine organisms; and (h) introducing low-level effects that may interrupt any of numerous behavioral stimuli (such as prey location, predator avoidance, mate location, other sexual stimuli, and homing behavior) necessary for the propagation of marine species and for the survival of those species higher in the marine food web.

The damage from an oil spill will depend on a number of factors, including: (a) the amount of oil spilled; (b) how much weathering the oil experiences before contacting fish, larvae, or eggs; (c) the depth at which the various life stages are found, since the concentrations and composition of oil falls off rapidly with depth; (d) how large an area will be impacted; and (e) the toxicity of the oil.

Although oil is toxic to finfish and shellfish, studies by Restrepo and Associates (1982) on the Ixtoc spills in the Gulf of Mexico found that "There is no significant direct economic effect of the oil spills on the commercial fishing industry of Texas measurable at the regional or major subregional levels. Additionally, there are no measurable indirect economic effects that stem from the impact on the commercial fishery sector." The analysis for this conclusion depended on both primary and secondary data. Secondary data included landings, effort, and value. Primary data were collected by telephone or in person and was an extensive survey of fishermen, dockside dealers, biologists, marine advisory agents, and local businessmen. The Ixtoc spills resulted in the spillage of 140 million gallons (3.5 million bbls) and the transport of a significant part of this from Mexican waters northward into coastal waters of the United States. It should be pointed out, however, that virtually no oil from these spills reached Texas' bays and estuaries.

(5) Phytoplankton and zooplankton, critical components of the marine ecosystem, have demonstrated differing reactions to oil (Wong et al., 1981; Gordon and Prouse, 1973; NAS, 1975; and Casey et al., 1982). Researchers have documented changes in the ecosystem after an oil spill passes in terms of type of primary and secondary producers. The primary productivity of phytoplankton may be reduced during an oil spill episode. Normal growth is restored after the episode passes. Low concentrations of oil have been shown to stimulate the growth of phytoplankton or to have no effect. Zooplankton populations may increase after a spill either because of their feeding on dead phytoplankton or on oil particles themselves. Pelagic plankton would probably suffer no major impact from a spill due to their wide distribution, rapid regeneration rates (9-12 hours for phytoplankton), rapid recruitment from adjacent waters, and large numbers (NAS, 1985). In an experiment conducted by the University of Texas on the toxicity of various oils to representative species of microalgae, Louisiana crude was not toxic (Parker and Menzel, 1974). The area off Louisiana near Timbalier Bay is one of the most productive areas of phytoplankton in the Gulf an shows no signs of deleterious effects from the oil production platforms according to the conclusions of the Offshore Ecology Investigation (OEI) (Ward et al., 1980).

(6) The most likely effects of oil on endangered whales based on the laboratory research (Geraci and St. Aubin, 1985; Goodale et al., 1981; and Gruber, 1981) are: (a) a mild deleterious but reversible effect on the skin; (b) possible eye irritation, which would be reversible unless exposure was prolonged; (c) possible short-term baleen fouling with possible feeding reduction for 1 or 2 days; (d) possible blowhole fouling and death due to respiratory stress for very young animals in heavy oil; and (e) temporary food reduction or contamination, and oil ingestion. Potential but unlikely effects include: (a) possible mortality due to respiratory stress; (b) possible mortality to young or already stressed animals immediately after a spill, due to ingestion of oil or inhalation of vapors; and (c) possible mortality due to stress if individuals are already stressed. Mortality has not been verified for any cetaceans due to an oil spill.

(7) Short-term biological loss occurs from an oil spill by direct kill through coating and asphyxiation, by contact poisoning or incorporation of water-soluble toxic carcinogenic or mutagenic components of oil, or by destruction of the generally more sensitive juvenile forms of organisms or of the food source of higher trophic species and by modification of habitats, delaying or preventing recolonization (Blumer, 1971).

(8) The severity of oil pollution on different organisms in various habitats varies from no effect to responses of avoidance, decreased activity, or physiological stress. Not only do different species react differently, but different life stages of an organism will show different tolerances to petroleum hydrocarbons. What is toxic to one organism may not be toxic to another. The concentration of hydrocarbons in marine organisms exposed to oil reflects various levels of uptake, metabolism, storage, and discharge. In general, benthic algae, zooplankton, benthic invertebrates, and fish can depaurate hydrocarbon accumulated after exposure to oil. Bivalves, including clams, oysters, and mussels, do not possess the enzyme system, or detoxification system as it is called, and tend to accumulate hydrocarbons (Lee, 1977).

(9) There is still little known about the long-term or sublethal effects of oil contamination. Long-term or sublethal effects due to low level concentrations of oil in the environment would be due to oil entering the Gulf from many sources. Spills from oil operations are just one of the sources. For a discussion on the subject, see Section IV.B.2.

d. Factors Affecting the Severity of Oil Spill Impact

The ultimate impact and recovery of a coastal area or offshore environment contacted by spilled oil depend on a number of interacting factors. Criteria in predicting the degree of oil spill damage to a shoreline are presented in Table IV-21 of the Final Regional EIS. These criteria are oil slick characterisitcs, the likelihood of oil spill contact, biological and geomorphological coastal features, and expected countermeasure effectiveness. The dispersion of oil in water, its movements, chemical modifications, effects on aquatic organisms and the shoreline, and persistence in the sea are all influenced by: (1) type and characteristics of the oil (for example, viscosity and percent aromatics); (2) amount and duration of oil spilled; (3) state of the sea, the currents, and wave activity; (4) location of the spill, including the physiography of the area and the distance from shore; (5) the geographical and morphological configuration of the affected coast, including textural characteristics of shore sediments; (6) climatic conditions, in particular temperature, wind, and solar radiation; (7) the value and/or characteristics of an area, in particular the biota present and the socioeconomic considerations; (8) season of spill occurrence; (9) previous exposure of the area to oil; (10) exposure to other pollutants; and (11) effectiveness of mitigating measures taken by appropriate Federal and State agencies.

For a more detailed discussion of some of these factors, see Volume 1, Section IV.B.3.d. of the Final Regional EIS. Because changes and updated material exist for the Final Regional EIS subsection, *Interaction with Coastal Environments*, it is modified below. In addition, new material on toxic effects is included.

Toxic Effects

The toxicity of petroleum on marine organisms is dependent upon the concentration and composition of its individual hydrocarbons at the time of impact. The relative impact of the oil will shift as spilled oil weathers due to the change in its chemical composition.

Crude oil is a complex mixutre of alkanes (aliphatic), naphthenes (cycle-paraffinic), aromatics, and asphaltics (asphaltenic and heterocyclic compounds containing oxygen, sulfur, or nitrogen). The low molecular weight components are considered acutely toxic but are rapidly lost through evaporation and solution during the first days of a spill. High molecular weight aliphatics are the least toxic, although they may have an anesthetic or narcotic effect if concentrations were great enough. As part of the slick on the surface of the water, they may coat marine birds.

In general, the relative toxicity of an oil is directly proportional to its aromatic content. Studies have shown lower molecular weight aromatic hydrocarbons (benzene and toluenes) to be moderately toxic to a variety of animals. Intermediate molecular weight aromatic hydrocarbons (naphthalenes) have been found toxic to phytoplankton and many species of aquatic animals. However, the benzenes and naphthalenes are quickly lost to the atmosphere or diluted into the water docolumn. Higher boiling aromatics act as slower poisons than low-boiling aromatics but are equally severe in their effects. The most toxic aromatics are phenanthrenes. Some aromatics that exist in low concentrations in crude oil have been found to be carcinogenic (Blumer, 1971). The polynuclear aromatic hydrocarbons exhibit very low solubilities and are generally most resistent to weathering processes. These and the toxic NSO compounds, as well as most of the heavy metals found in crude oil, will tend to remain in the tarry residue.

Although laboratory toxicity tests show that the deleterious effects of oil are related to its chemical components, the form of oil at sea is just, if not more, as important in determining toxicity. That portion of the oil that dissolves, the water soluble fraction (WSF), appears to be the most highly toxic to organisms, possibly due to the easier uptake of oil in this form (Ottway, 1976; Winters and Parker, 1977). Water-in-oil emulsions of spilled oil are likely to cause biological damage due to physical effects, while oil-in-water emulsions probably cause more biological damage due to toxic effects. Oil in dispersed droplets exhibits slightly less toxicity than the WSF's. Therefore, although high molecular weight aromatics are least degraded in oil and show high toxicity in laboratory tests, the relative toxicity of the lower boiling aromatics may be more important due to their enrichment in the aqueous phase, specifically the naphthalene hydrocarbons.

Toxicities vary between oil types because the concentration and composition of individual hydrocarbons with the oil vary. In general, refined oils are considered more toxic than crude oils due their high aromatic hydrocarbon concentrations and their greater ability to mix into the water column as a result of their less viscous nature. In general, spills of crude oils, residual fuel, and lubricating oils are more likely to cause biological damage by virtue of their viscous physical properties when considered over a length of time, while spills of refined oil, including gasolines and kerosenes, are likely to cause biological damage by virtue of their toxic nature over a relatively short period of time (Ottway, 1976).

The bioassay that has been used to determine oil toxicity is the LC_{50} test. The LC_{50} is the concentration causing 50% mortality over a given period of time, usually 24, 48, or 96 hours. The toxicity test has limitations due to the number of variables involved such as the complex mixture of oil, test parameters, and biological factors (life stage, sex, contamination history of the organisms). Acute lethal bioassays do provide information on which components of oil are toxic and a basis to compare relative toxicities of oil to species and life stages. However, often laboratory toxicity results have no relation to oil spill effects observed in the field. Determination of toxicity thresholds was the first approach used in oil pollution research. Currently, reserch at the physiological level is concerned with mechanisms of hydrocarbon toxicity and sites of toxic action. Research at the ecological level is focused on using large field enclosures or mesocosms with known dosages of oil and flowthorugh systems using field concentrations of oil in the laboratory.

Soluble aromatic hydrocarbons can be lethal to adult fishes in low concentrations (1-100 ppm) and to the more sensitive larval stages at even lower concentrations (0.1-1 ppm). Crustaceans appear to be the most sensitive (1-10 ppm) while the fish and bivalves are moderately sensitive (10-100 ppm); however, lethal concentrations may be lower (0.1-1 ppm) for the more sensitive larval and juvenile forms. Studies cited by Evans and Rice (1974) show that certain fish eggs are extremely sensitive to the influence of oil products. For example, fertilized eggs of the plaice (*Rhombus macoticus*) were injured at concentrations of 0.01-0.1 ppm with 40%-100% of the hatched prelarvae showing some signs of degeneration during development and perishing (Nounou, 1980).

There are few laboratory studies concerning toxicity of oil to organisms indigenous to the Gulf of Mexico. Table IV-21 contains LC_{50} (concentration causing 50% mortality over a given period of time) values for some marine animals. Patterns of toxicity are evident in the results. The refined oils, No. 2 fuel oil and Bunker C oil, were much more toxic than the crude oils. The water-soluble fractions (WSF) were much more toxic than the oil-in-water dispersions (OWD).

Anderson et al. (1974) ranked test species according to increasing sensitivity to oil, from least sensitive to most sensitive as follows: sheepshead minnow, silverside, longnose killfish, brown shrimp (postlarvae), grass shrimp, and mysid. They discovered that there was no relationship between phylogenetic position or habitat and relative sensitivity to oil. Rabalais et al. (1981) found that eggs and larvae of red drum were very sensitive to Ixtoc 1 oil accommodated in seawater (OAS). Rossi et al. (1976) concluded that the WSF of the crude oils were less toxic than either No. 2 fuel or Bunker C oil. However, the WSF were more toxic than those obtained from the Anderson et al. (1974) study. This difference was due to the preparation of the WSF in the Anderson et al. (1974) study which resulted in loss of toxic, volatile compounds, e.g., benzene and naphthalene. The results obtained by Dillon et al. (1978) indicated that the isopod, *Ligia exotica*, was very tolerant to WSF and OWD of No. 2 fuel oil; the WSF failed to produce 50% mortality. Neff et al. (1976) compared tolerances of life stages of different species of shrimp to the WSF of No. 2 fuel oil. They found that the juveniles and adults were more sensitive than the larvae in all species, except grass shrimp which showed the opposite trend.

Interaction with the Shoreline

The most harmful effects of an open-water oil spill occur if the slick reaches land. Once oil contacts a coastline, its distribution and persistence are governed by a number of factors that include chemical and physical dispersion processes affecting the oil, the natural degradation of the oil, and other environmental factors. Most important is the level of kinetic energy of the shorefront which determines the abrasion and sediment scouring that occurs from wave activity. Other factors contributing to the breakup of the stranded slick include the tidal cycle and stage of the area, the amount of oil stranded, the grain size of the beach sediment, and the effects of rain that might occur soon after the arrival of the oil slick. Rain and the sediment grain size contribute to the penetration of the oil into the ground.

Table IV-20 of the Final Regional EIS outlines significant physical factors influencing how long oil remains stranded on a shorefront. These include the type of oil, the thickness of oil on the shore surface, the depth of oil penetration, the wave energy level at the shoreline, and the air temperature. Oil coming ashore during unusually

Table IV-21

LC_{50} Values for Some Gulf of Mexico Marine Animals

Species	LC_{50} (hours)	Southern Louisiana Crude		Kuwait Crude		No. 2 Fuel Oil		Bunker C Oil		Weathered IXTOC I
		OWD[7] (ppm)	WSF[8] (ppm)	OWD (ppm)	WSF (ppm)	OWD (ppm)	WSF (ppm)	OWD (ppm)	WSF (ppm)	OAS[9] (ppm)
Mysid (*Mysidopsis almyra*)[1]	48	37.5	8.7	63.0	6.6	1.3	0.9	-	0.9	-
Grass shrimp (*Palaemonetes pugio*)[1]	96	200	>16.8	6,000	>10.2	3.0	3.5	-	2.6	-
Brown shrimp postlarvae (*Penaeus aztecus*)[1]	96	>1,000	>19.8	-	-	9.4	4.9	-	1.9	-
Sheepshead minnow (*Cyprinodon variegatus*)[1]	96	29,000	>19.8	>80,000	-	93	6.3	-	3.1	-
Silverside (*Menidia beryllina*)[1]	96	3,700	5.5	9,400	6.6	-	3.9	-	1.9	-
Longnose killifish (*Fundulus similus*)[1]	96	6,000	16.8	14,800	>10.4	33	3.9	-	1.69	-
Copepods of coastal Texas and laboratory-reared amphipods[2]	96	-	-	-	-	-	-	-	-	>13.5
Red drum eggs and larvae (*Sciaenops ocellata*)[3]	24	-	-	-	-	-	-	-	-	5.1
Polychaete (*Capitella capitata*)[4]	96	-	12.0	-	9.8	-	2.3	-	0.9	-
Isopod (*Ligia exotica*)[5]	96	-	-	-	-	36.5	•10	-	-	-
Brown Shrimp (*Penaeus aztecus*)[6]	96									
Postlarvae		-	-	-	-	-	6.6	-	-	-
Early juveniles		-	-	-	-	-	3.7	-	-	-
Late juveniles		-	-	-	-	-	2.9	-	-	-

Table IV-21. LC_{50} Values for Some Gulf of Mexico Marine Animals (continued)

		Southern Louisiana Crude		Kuwait Crude		No. 2 Fuel Oil		Bunker C Oil		Weathered IXTOC I
Species	LC_{50} (hours)	OWD[7] (ppm)	WSF[8] (ppm)	OWD (ppm)	WSF (ppm)	OWD (ppm)	WSF (ppm)	OWD (ppm)	WSF (ppm)	OAS[9] (ppm)
White Shrimp (*Penaeus setiferus*)[6]	96									
Postlarvae		-	-	-	-	-	1.4	-	-	-
Juveniles		-	-	-	-	-	1.0	-	-	-
Grass Shrimp (*Palaemonetes pugio*)[6]	96									
Larvae		-	-	-	-	-	1.2	-	-	-
Postlarvae		-	-	-	-	-	2.4	-	-	-
Adults		-	-	-	-	-	3.5	-	-	-
Opossum Shrimp (*Mysidopsis almyra*)[6]	96									
Postlarvae		-	-	-	-	-	1.75	-	-	-
Adults		-	-	-	-	-	0.65	-	-	-

[1] Anderson et al., 1974.
[2] Lee et al., 1980.
[3] Rabalais et al., 1981.
[4] Rossi et al., 1976.
[5] Dillon et al., 1978.
[6] Neff et al., 1976.
[7] Oil-in-water dispersions.
[8] Water-soluble fraction.
[9] Oil accommodated in seawater.
[10] Failed to produce 50% mortality.

high tides or storm surges can have a particularly long-term impact on the beaches because it is deposited above the zone of normal wave activity.

RPI's Environmental Sensitivity Index

Scientists of the Research Planning Institute, Inc. (RPI) have developed a system which characterizes and ranks geomorphic coastline types with respect to the potential and relative susceptibility to oil spill impact. Vegetation characteristics, shoreline energy regimes, substrate textures that affect depth of oil burial, and other relevant geomorphic features are categorized in order to develop an environmental sensitivity index (ESI). This ESI qualifies the potential long-term persistence and environmental damage of oil on coastline types.

Table IV-23 of the Final Regional EIS presents the ESI ranking for the Gulf Coast. The ESI ranks sheltered mangrove forests and salt marshes highest, that is, most susceptible to oil spill impact of the 10 categories of coastal types. Factors brought out by this classification include: (1) the depth of oil burial and the thickness of oiled sediment increases as the grain size coarsens; (2) oil can be buried by rapid changes in beach morphology due to natural beach cycles of erosion and deposition or migrating beach cusps; and (3) fine-grained beaches are far more conducive to the mechanical removal of spilled oil than are coarse-grained beaches.

RPI has completed a detailed coastal resource sensitivity evaluation of the Gulf of Mexico shoreline and developed strategic planning profiles to minimize the impact from oil spills for the Marine Industry Group. This is discussed in more detail in Section IV.B.8.

7. Effects of Catastrophic Oil Spills

The following discussion serves as a worst case analysis of the potential effects of hypothetical catastrophic spills of 100,000 bbls or greater on representative areas of sensitive resources in the Gulf. Section 1502.22 of the CEQ regulations does not require agencies to use a worst case scenario for each species or resource analyzed, and the use of any one scenario (affecting only a single species) would leave questions as the effects of such a worst case scenario on other species or resources. To resolve this problem, the possible effects are analyzed on each resource of concern in selected representative target areas. Where essential information is missing, reasonable projections are made of the worst case with respect to the species or resources.

Two areas were chosen for this analysis, and two counties/parishes were selected based on the diversity of exposed sensitive resources considered representative of their particular regions. The selected areas are considered to be affected by a hypothetical spill with characteristics identified in the following scenario.

Table IV-22 provides the available quantification of the sensitive resources in Lafourche Parish and Galveston County which are analyzed.

Approximately 100,000 bbls or greater of Louisiana crude are released within close proximity to the selected target. Weather conditions hamper cleanup activities and the oil is rapidly washed ashore, contacting the coastline within hours and affecting the entire length of the exposed portion of the county/parish (shown on Visual No. 14) within the first three days after its release.

The history of major oil spills in the Gulf indicates that the average size oil spill is about 17,000 bbls (Section IV.B.6.a.), which is the typical size spill analyzed in the sections of this document pertaining to the potential impacts resulting from the proposed action.

Table IV-22

Exposed Sensitive Resources in Selected Catastrophic Spill Targets

County/Parish	Linear Extent Miles	Exposed Coastline	Acreage
Lafourche Parish, Louisiana			
Total Exposed Coastline	122.6	-	-
Major Shorefront Recreational Beaches	7.6	6.2%	-
Wetlands	89.9	72.7%	477,427
Mangroves	22.1	18.1%	2,000
Seagrass Beds	-	-	2,326
Galveston County, Texas			
Total Exposed Coastline	139.4	-	-
Major Shorefront Recreational Beaches	47.5	34.0%	-
Wetlands	54	38.7%	6,310

Impacts on a Representative Central Gulf Area

Lafourche Parish, Louisiana, was selected as the target for the CPA. It contains a high diversity of sensitive resources representative of much of the coastline of the area.

Lafourche Parish is located west of the Mississippi River and is part of the Mississippi Deltaic Plain Region. The shoreline of the parish fronts on the open Gulf to the south and on estuaries to the east and west. The predominant features of the shoreline are the numerous small bays and inlets to the saline marsh which is generally exposed to Gulf seawater. The shoreline also includes marsh and barrier islands. The marsh islands lie within the estuaries behind the barrier islands. The Gulf front portions of the barrier islands and the mainland marsh are often made up of beach ridges, some of which serve as recreational beaches. The areas behind these ridges are protected from the full force of the open Gulf by the energy-absorbing characteristics of the beaches.

Most of the coastal area of the parish provides valuable habitat for coastal and marine birds and furbearing animals. The wetlands and the estuaries are also very important to the recreational and commercial fisheries of the south Louisiana area.

Sensitive Coastal Habitats: Coastal wetlands in Lafourche Parish consist of forested wetlands (122,512 acres), non-forested wetlands (354,915 acres), and mangroves (2,000 acres). Within these wetlands there are no forested wetlands, 88.9 linear miles of non-forested wetlands, and 22.1 linear miles of mangroves exposed if an oil spill occurred. It is assumed that the spill would contact the Gulfward fringe of the mangroves and non-forested wetlands.

The impact along the Gulfward fringe of the wetlands is estimated to range from complete mortality to reduction in growth throughout the duration of the spill for emergent plants in non-forested wetlands. No forested wetlands are exposed; consequently, no impact is expected. Impacts to mangroves is expected to range from complete mortality to reduction in growth for plants contacted. Recovery of the impacted areas to prespill conditions could take several years.

There are 2,325 acres of seagrass beds in Lafourche Parish; 2,320 acres of these are considered exposed if an oil spill occurred. It is assumed that the oil spill would be evenly dispersed over the seagrass beds. The interitidal seagrass beds are expected to experience a reduction in growth for most species, and mortality of invertebrates and larval vertebrates is expected. Recovery of the impacted areas to prespill conditions could take several seasons.

Water Quality: In general, a catastrophic oil spill of 100,000 bbls would likely result in substantial adverse impacts on water quality. Very large oil spills have occurred in the cases of Ixtoc I (wellhead blowout/3.1 million bbls), Bravo (surface platform blowout/175,000 bbls), *Argo Merchant* (tanker accident/180,000 bbls) and *Amoco Cadiz* (tanker accident/1.5 million bbls). Under such a catastrophic oil spill scenario, the oil would be rapidly released and widely dispersed by the action of wind and currents, resulting in the transport of oil to shallow, coastal water bodies. Although some of the oil released would be distributed throughout the water column in the vicinity of the wellhead in the case of a blowout and probably a very large surface water area would be covered by floating oil, it is the oil reaching the relatively shallow (197 ft) coastal areas and embayments that would cause the most severe water quality impacts. In the shallow areas, oil might be initially dispersed throughout the water column and might also become entrained in suspended particles and bottom sediments, subsequently being reintroduced into the water column as a result of tide, wind, or current action. Thus, elevated hydrocarbon levels may result in the water column for an extended period of time. Furthermore, although stormy conditions would likely enhance the break-up and dispersion of the spilled oil, they would also impede spill cleanup procedures. For a more indepth discussion on "Oil in the Water Column," see Section IV.B.6.

Air Quality: Assuming the most severe climatic conditions, potential impacts on air quality affecting the human environment over Lafourche Parish could be high in the event of a 100,000 bbl oil spill occurring and contacting the coastal area. Emissions due to evaporation of total hydrocarbons (THC) would be approximately 2,850 tons the first hour and 1,450 tons the second hour. Over a 10-day period at least 45% of this spill would evaporate at a decreasing hourly rate. The result of these emissions would be to place in the atmosphere a large number of volatile organic compounds (VOC). These compounds are a constituent in the formation of photochemical oxidants (O_X) known as ozone.

Lafourche Parish presently exceeds national air quality standards for O_X. The addition of emissions from a major oil spill under stagnate air/long sunny day conditions could create poor air quality (smog) for an indeterminate period of time. The intensity and duration of poor air quality would be controlled by wind direction, wind speed, the season of the year, and the amount of sunshine present during evaporative emissions. Conditions creating smog are rarely present for periods exceeding 24 hours due to variable coastal winds and the relatively flat terrain of Lafourche Parish; however, the potential for high air quality impacts exist as a result of a major oil spill.

Endangered and Threatened Species: Impacts on endangered and threatened species would occur when the oil spill reached nearshore and coastal areas of Lafourche Parish.

Bald eagles and brown pelicans occur in this area. These endangered bird species could become fouled with oil while feeding in the coastal area. The adult birds could die from oil fouling or could transfer the oil contamination to their eggs or young, resulting in population losses. Moderate losses of these endangered birds could occur if the oil spill was widespread on the surface of the water and persisted over a 1-2 week period.

A large oil spill in this area could result in a major impact on endangered and threatened sea turtles. Both loggerhead and ridley turtles feed in these nearshore waters; no recent turtle nesting has been reported for this area. The oil contamination could disorient and/or asphyxiate turtles and/or impact feeding activities and food sources.

It is unlikely that American alligators would be directly impacted by an oil spill in this area, as their habitat is more inshore than coastal. However, they could ingest oil-contaminated animals, which could result in a very low population loss.

A catastrophic oil spill in this area is unlikely to result in a major impact to endangered marine mammals because few occur or feed in this nearshore area. However, there could be a moderate impact to non-endangered cetaceans (bottlenose dolphins).

Coastal and Marine Birds: The coastal wetlands of Lafourche Parish, Louisiana, provide an important habitat for several species of overwintering waterfowl and shorebirds. The area is habitat for a number of herons, egrets, gulls, terns, rails, plovers, and other shorebirds, many of which are overwintering species. There are several nesting colonies of wading birds (i.e., egrets and herons), and Forsters and least terns nest on exposed beach areas.

It is likely that large numbers of overwintering waterfowl, shorebirds, and other bird species could be fouled with oil and die if an oil spill occurred in early spring prior to/during the spring migration period. Breeding and nesting adult birds could become contaminated with oil while feeding in coastal waters or along the shore, and/or could ingest oil-contaminated food. Nesting areas are generally located above high tide and may not be affected, but feeding occurs offshore, nearshore, or in tidally influenced coastal areas. If the spilled oil contaminated coastal bottom sediments, feeding areas could be contaminated for several years. As a result, breeding and feeding areas in the coastal areas of Lafourche Parish, Louisiana, may not support coastal and marine bird populations for 2-5 years and local bird populations could be severely depressed in variety and numbers.

Commercial Fishing Industry: The following assumptions were used in the analysis of the impacts on the commercial fishing industry:

- The oil spill occurs during the most critical period for the commercial fishery.
- Marine commercial fisheries landings reported for a county/parish are equated to marine commercial fish dependent on bays and estuaries or caught in that county/parish.

Nearly all species significantly contributing to the Gulf's commercial fisheries are estuarine dependent. Bays and estuaries serve as nurseries and/or spawning grounds for commercial finfish and shellfish. Some species, such as oysters and spotted seatrout, live their entire life cycle in the estuary.

A catastrophic oil spill contacting these areas within the exposed portion of the county/parish would have a devastating effect. Most organisms would be killed and habitats destroyed. The results would be ecosystem destruction within the bays and estuaries. Several year-classes of commercial fisheries would be removed. The recovery of the fisheries would depend on how quickly the habitats (marshes, seagrass beds) could be re-established. The spill would also affect long-term productivity nearshore as the nutrient input from bays and estuaries would decrease sharply.

According to Evans and Rice (1974), the impacts on fishery resources from oil pollution are: (a) killing organisms through coating and asphyxiation; (b) killing organisms through contact poisoning; (c) killing organisms through exposure to the water soluble toxic components of oil at some distance in time and space from the accident; (d) destroying the generally more sensitive juvenile organisms; (e) destroying sources of food and shelter; (f) incorporating sublethal amounts of oil and oil products into organisms (resulting in reduced resistance to infection and other stresses); (g) incorporating carcinogenic and potentially mutagenic chemicals into marine organisms; and (h) introducing low-level effects that may interrupt any of numerous behavorial stimuli (such as prey location, predator avoidance, mate location, other sexual stimuli, and homing behavior) necessary for the propagation of marine species and for the survival of those species higher in the marine food web.

Soluble aromatic hydrocarbons can be lethal to adult fishes in low concentrations (1-100 ppm) and to the more sensitive larval stages at even lower concentrations (0.1-1 ppm). Crustaceans appear to be the most sensitive (1-10 ppm) while fish and bivalves are moderately sensitive (10-100 ppm); however, lethal concentrations may be lower (0.1-1 ppm) for the more sensitive larval and juvenile forms. Studies cited by Evans and Rice (1974) show that certain fish eggs are extremely sensitive to the influence of oil products. For example, fertilized eggs of the plaice (Rhombus macoticus) were injured at concentrations of 0.01-0.1 ppm with 40%-100% of the hatched prelarvae showing some signs of degeneration during development and perishing (Nounou, 1980).

An oil spill greater than 1,000 bbls contacting bays within 10 days of the spill is defined as having severe medium-term (1-3 years duration) consequences on invertebrate and vertebrate fisheries resulting in fishing being altered in these areas. Based on this definition, a catastrophic oil spill would have severe long-term (many years) effects. The level of impact would be very high, i.e., an economic loss of greater than 5% to the commercial fishing industry, many fishermen out of work, and secondary employment (processing plants, etc.) substantially affected.

A catastrophic oil spill would have a major impact on the oyster, shrimp, and blue crab fisheries in Lafourche Parish, Louisiana. Lafourche Parish contains oyster seed ground reservations and private oyster lease areas. The bays and estuaries within Lafourche Parish provide nursery areas for shrimp and blue crab. The total marine commercial fisheries landings in Lafourche Parish for 1983 was 14,798,689 lbs worth $21,416,990 (Table IV-23). The total oyster, shrimp, and blue crab landings in Lafourche Parish for 1983 were 929,882 lbs worth $1,362,606; 9,275,909 lbs worth $17,598,109; and 2,377,020 lbs worth $706,806, respectively (Table IV-23). The total oyster, shrimp, and blue crab landings in Louisiana for 1983 were 13,229,377 lbs worth $17,621,237; 76,953,758 lbs worth $130,911,626; and 19,616,001 lbs worth $6,366,172, respectively (Table IV-23). There would be a loss of at least $1,362,606, $706,806, and $17,598,109 worth of oysters, blue crab, and shrimp, respectively.

Table IV-23

Lafourche Parish Landings for 1983

Lafourche Parish, 1983	Pounds	Dollars
Total Marine Commercial Fisheries Landings	14,798,689	21,416,990
Total Oyster Landings	929,882	1,362,606
Total Shrimp Landings	9,275,909	17,598,109
Total Blue Crab Landings	2,377,020	706,806
State of Louisiana, 1983		
Total Oyster Landings	13,229,377	17,621,237
Total Shrimp Landings	76,953,758	130,911,626
Total Blue Crab Landings	19,616,001	6,366,172

Source: National Marine Fisheries Service, Personal communication, 1985.

Major Shorefront Recreational Beaches: The shorefront of Lafourche Parish is characterized by 14 miles of sandy beach shorefront; however, there are no designated parks or recreational support facilities encouraging public recreation of these beaches. About six miles of barrier island beach is isolated from the mainland on East Timbalier Island, while eight miles of beach at Elmers Island and Fourchon Beach is partially accessible and receives a great deal of recreational use. These beaches attract almost exclusively day use and campers interested in Gulf fishing and crabbing. A large oil spill as described would remove this eight miles of recreational beach from fishermen and crabbers for one week to 60 days depending on currents, tides, weather, access, and cleanup effectiveness. The greatest impact on recreational use of this beach would occur if this spill beached during the spring and summer months when the crab and speckled trout runs are in progress. After the spill has been cleaned and the beaches returned to prespill conditions, use and enjoyment of Lafourche Parish beaches is likely to return to normal.

Impacts on a Representative Western Gulf Area

Galveston County, Texas was selected for the WPA. It contains a high diversity of sensitive resources representative of much of the coastline of the area.

Galveston County is located southeast of Houston, Texas, with shoreline fronting on both Galveston Bay and the open waters of the Gulf of Mexico. The Galveston Bay portion of the shoreline is protected from the full force of the open Gulf by Galveston Island and Bolivar Peninsula. The Bay front shoreline consists predominantly of wetlands and developed areas, while the Gulf front shoreline is typically sand beach with areas that are considered to be major recreational beaches.

Much of the Galveston County area provides valuable habitat for coastal and marine birds and Galveston Bay supports the largest oyster, blue crab, and shrimp fishery in the State of Texas.

Table IV-22 provides the available quantification of the sensitive resources in Galveston County which are analyzed below.

Sensitive Coastal Habitats: Coastal wetlands of Galveston County consist of non-forested wetlands (68,310 acres). Within these wetlands there are 54 linear miles of non-forested wetlands.

The impact along the Gulfward fringe of the wetlands is estimated to range from complete mortality to reduction in growth throughout the duration of the spill for emergent plants. Recovery of impacted areas to prespill conditions could take several years.

There are 4,787 acres of seagrass beds in Galveston County; up to 1,596 acres of these are considered exposed if an oil spill occurred. It is assumed that the oil spill would be evenly dispersed over the seagrass beds. The interitidal seagrass beds are expected to experience a reduction in growth for most species, and mortality of invertebrates and larval vertebrates is expected. Recovery of the impacted areas to prespill conditions could take several seasons.

Water Quality: In general, a catastrophic oil spill of 100,000 bbls would likely result in substantial adverse impacts on water quality. For a discussion on this topic, refer to the previous write-up concerning Impacts on a Representative Central Gulf Area.

Air Quality: Assuming the most severe climatic conditions, potential impacts on air quality affecting the human environment over Galveston County could be high in the event of a 100,000 bbl oil spill occurring and contacting the coastal area. Emissions due to evaporation of THC would be 2,850 tons the first hour and 1,450 tons the second hour. Over a 10-day period at least 45% of this spill would evaporate at a decreasing hourly rate. The result of these emissions would be to place in the atmosphere a large number of volatile organic compounds (VOC). These compounds are a constituent in the formation of photochemical oxidants (O_X) known as ozone.

Galveston County presently exceeds national air quality standards for O_X. The addition of emissions from a major oil spill under stagnate air/long sunny day conditions could create poor air quality (smog) for an indeterminate period of time. The intensity and duration of poor air quality would be controlled by wind direction, wind speed, the season of the year, and the amount of sunshine present during evaporative emissions. Conditions creating smog are rarely present for periods exceeding 24 hours due to variable coastal winds and the relatively flat terrain of Galveston County; however, the potential for high air quality impacts exist as a result of a major oil spill.

Endangered and Threatened Species: Impacts on endangered and threatened species would occur when the oil spill reached nearshore and coastal areas of Galveston County, Texas.

Overwintering or migrating bald eagles and peregrine falcons could occur in this area. These endangered bird species could become fouled with oil while feeding in the coastal area. The adult birds could die from oil fouling or could transfer the oil contamination to their eggs or young, resulting in population losses. Moderate losses of these endangered birds could occur if the oil spill was widespread on the surface of the water and persisted for a 1-2 week period, and their prey species become contaminated with oil.

A large oil spill in this area could result in a major impact on endangered and threatened sea turtles. Both loggerhead and ridley turtles feed in these nearshore waters. No recent turtle nesting has been reported for this area. The oil contamination could disorient and/or asphyxiate turtles and/or impact feeding activities and food sources. An extensive oil spill in this sea turtle feeding habitat could result in a high impact to leatherback, loggerhead, and ridley sea turtles.

It is unlikely that American alligators would be directly impacted by a major oil spill in this area, as their habitat is more inshore than coastal. However, they could ingest oil- contaminated animals, which could result in a very low population loss.

A catastrophic oil spill in this area is unlikely to result in a major impact to endangered marine mammals because few occur in this nearshore area. However, there could be a moderate impact to non-endangered cetaceans (bottlenose dolphins).

Coastal and Marine Birds: The coastal wetlands of Galveston County, Texas, provide an important habitat for about 25 species of overwintering waterfowl and shorebirds. The area is also habitat for a number of heron, egret, ibis, gull, and tern species, many of which overwinter in the area. There are several nesting colonies of wading birds (i.e., egrets, herons, and ibis), and Forster's, caspian, and least terns nest in beach areas.

It is likely that large numbers of overwintering waterfowl, migrating shorebirds, and other bird species could be fouled with oil and die if an oil spill occurred during the fall/winter overwintering period or spring through fall for nesting birds. Breeding and nesting adult birds could become contaminated with oil while feeding in coastal waters or along the shore and/or could ingest oil-contaminated food. Nesting areas are generally above high tide and may not be affected, but feeding occurs offshore, nearshore, or in tidally influenced coastal areas. If the spilled oil contaminated coastal bottom sediments, feeding areas could be contaminated for several years. As a result, breeding and feeding areas in the coastal area of Galveston County, Texas, may not support coastal and marine bird populations for 2-5 years, and local bird populations could be severely depressed in variety and numbers.

Commercial Fishing Industry: A catastrophic oil spill would have a major impact on the oyster, shrimp, and blue crab fisheries in Galveston County, Texas. Bryan (1981) reports that about 80% of the oyster production in Texas comes from the Galveston Bay system. The bays and estuaries within Galveston County provide nursery areas for shrimp and blue crab. The total marine commercial fisheries landings in Galveston County for 1982 was 6,377,600 lbs worth $11,099,246 (Table IV-24). The total oyster, shrimp, and blue crab landings in Galveston County for 1982 were 1,615,700 lbs worth $2,289,398; 3,862,300 lbs worth $8,341,584; and 471,400 lbs worth $167,797, respectively (Table IV-24). The total oyster, shrimp, and blue crab landings in Texas for 1982 were 3,633,200 lbs worth $5,313,726; 41,760,500 lbs worth $97,189,452; and 8,018,700 lbs worth $2,378,416, respectively (Table IV-24). There would be a loss of at least $2,289,398 (45% of the value for Texas), $167,797, and $8,341,584 worth of oysters, blue crab, and shrimp, respectively.

Table IV-24

Galveston County Landings for 1982

Galveston County, 1982	Pounds	Dollars
Total Marine Commercial Fisheries Landings	6,377,600	11,099,246
Total Oyster Landings	1,615,700	2,289,398
Total Shrimp Landings	3,862,300	8,341,584
Total Blue Crab Landings	471,400	167,797
State of Texas, 1982		
Total Oyster Landings	3,633,200	5,313,726
Total Shrimp Landings	41,760,500	97,189,452
Total Blue Crab Landings	8,018,700	2,378,416

Source: National Marine Fisheries Service, Personal communication, 1985.

Major Shorefront Recreational Beaches: The entire shorefront of Galveston County from Chambers County to Brazoria County consists of barrier island beach. Almost the entire length of Galveston Island, inclusive of East Beach, West Beach, Galveston Island State Park and designated recreational portions of Bolivar Peninsula, constitutes about 50 linear miles of major recreational beaches directly facing the Gulf in Galveston County. A catastrophic oil spill under the scenario described would remove the entire shorefront of Galveston County from recreational use for two weeks to two months depending on currents, tides, weather, access, and cleanup effectiveness. Should such a catastrophy occur during the spring and summer months, the resulting recreational impacts, especially in Galveston Island, would be catastrophic as an entire recreational season would be annihilated. This would cause serious economic implications throughout Galveston County as the community is highly dependent on the viability of its shorefront recreational resource for its economic well being. Although there could be some residual effects on tourism, the recreational aspects of Galveston County should return to normal when the beaches have returned to prespill conditions. Sand removal and replacement is likely to be warranted along the most intensively utilized recreational beaches to expedite the return to normality.

8. Oil Spill Containment/Cleanup Capabilities and Effectiveness

The first line of defense for accidental oil spills is prevention; however, when a spill occurs, rapid decisions must be made on how to best minimize the impacts. Available equipment is of no use without a preplanned approach as to how to use it. Improvements in prespill contingency planning at all levels of government and private industry in past years have reduced confusion and increased the efficiency and effectiveness of cleanup response. By knowing the nature of the spilled material as well as slick dynamics, the characteristics of the threatened environment and the available equipment and manpower, the responsible party can prioritize and evaluate selected actions. The primary thrust of the National Contingency Plan is to provide a Federal response capability at the regional level. The Federal response program established on-scene coordinators (OSC) to direct response for pollution or potential pollution incidents. The OSC notifies the responsible party for the spill and encourages the party to undertake proper countermeasures and mitigate the effect. The OSC observes and monitors cleanup progress and provides advice and counsel to the spiller as necessary. In addition, there is a Regional Response Team (RRT) made up of various Federal and State agency representatives which can be convened at the request of an OSC for advice or assistance in obtaining equipment or other support. At the national level the National Response Team (NRT), comprised of representatives of 12 Federal agencies, is also available to an OSC for major policy decisions or large-scale and specialized support not available through RRT or local resources. Scientific Support Coordinators are provided by NOAA and USEPA and are available upon the request of the OSC. This unique multi-agency working relationship gives an OSC quick access to equipment, personnel, and expertise needed to deal with situations where commercial assistance is limited or nonexistent. Sections I.B.5. of this document and IV.B.5. (Volume 1) of the Final Regional EIS present a full discussion on the Federal response program.

A group of oil companies involved in petroleum transportation in the Gulf of Mexico has established the Marine Industry Group (MIRG). MIRG has funded two oil spill contingency planning information projects which provide meaningful guidance and information to spill response personnel. The Resources and Logistics Element identifies the location of specific cleanup equipment/resources and provides deployment requirements and specifications. The Environmental Element describes Gulf of Mexico environments, identifies biologically and socioeconomically sensitive areas, and includes countermeasure considerations. The information is provided in two volumes: Volume 1 is an environmental overview of the Gulf of Mexico, including physical processes influencing the movement of spilled oil, a description of the environment, an analysis of potential spill impacts, and spill considerations for each type of environment. A bibliography of more than 700 citations and references is included. Volume 2 is divided into six sections, each section being a state or group of states (United States and Mexico). Each section includes: overview maps of the regions; detailed maps of each area (1:24,000 scale) within the regions; and facing pages describing important biological resources, reasons for sensitivity, and logistics data such as boat launch sites (Lindstedt-Siva et al., 1983).

In addition to the two projects mentioned above, MIRG has undertaken two other tasks; they have contracted the services of an oil spill consultant and conducted a resource capability analysis (Proceedings . . ., 1985). The contractor, O'Brien's Oil Pollution Service, Inc., is responsible for providing expertise on oil spill response, updating the Resources and Logistics Directory, and remaining current on Gulf of Mexico response capability. The second task, resource capability analysis, includes surveying current resources and assessing methods of improving oil spill response capabilities. A result of this analysis has been the addition of the Biegert Aviation ADDS Pack aerial dispersant spraying system.

a. Equipment Locations

Table IV-25 illustrates oil spill equipment availablility in the Gulf of Mexico area. Each category of Table IV-25 is divided into U.S. Coast Guard Captain-of-the-Port/Marine Safety Office (COPT/MSO) jurisdictions, with the listed cities being the office base for each Coast Guard area. Many of the establishments are located in the cities listed in the table, but others are dispersed in cities/towns throughout the jurisdiction of each COTP/MSO area.

This information and other information concerning the number and locations of cleanup operatives and establishments stocking oil spill cleanup equipment was taken from the computerized Spill Equipment Inventory System (SKIM) of the USCG, revised December 22, 1981; it was also acquired by personal communication with authorized personnel at the COTP/MSO in each area.

The category, "Number of Establishment with Oil Spill Cleanup Equipment on Hand," (Table IV-25) includes all those establishments that maintain a limited number of cleanup equipment in the event of a minor spill as a result of their oil- and gas-related activities, such as a coastal refinery. This equipment is also available to teams cleaning up large spills if the need arises. The figures under the title, "Number of Cleanup Establishments," are those operatives organized for the sole purpose of containment and cleanup of an oil spill. Of these identified cleanup services, several are capable of cleaning up oil spills in the offshore environment, as well as providing the necessary equipment and trained teams to rapidly respond to the removal or containment of oil along the coastline.

Along the WPA coastline, there are 55 establishments which maintain oil spill response equipment; 22 cooperatives, private or government operatives, or contractors whose sole purpose is oil spill response, of which 6 have offshore response capabilities.

In the CPA, the following services are available: 23 establishments have oil spill cleanup equipment, 22 more are designated oil spill response operatives, and 6 of these have offshore oil response capabilities.

b. Equipment Effectiveness

A wide variety of equipment is available to aid in the containment and cleanup of spilled oil. Current designs allow for cleanup operations in various stages. In some situations, however, it has proven beneficial to use cleanup personnel as opposed to mechanical equipment as the tool for cleanup operations. Containment and cleanup operations are labor intensive operations due to the complexity of the environment they are conducted in and the constant monitoring/planning efforts associated with them. Not only are these operations labor intensive, but the

Table IV-25

Availability of Oil Spill Cleanup Equipment

U. S. Coast Guard COTP/MSO Area	Number of Establishments with Oil Spill Cleanup Equipment on Hand[1]	Number of Cleanup Establishments[2] Contractor	Cooperative	Private	Government	Total	Grand Total of Establishments
Corpus Christi	14	2	2	1	2	7	21
Galveston	8	3	0	1	1	5	13
Houston	19	3	1	0	1	5	24
Port Arthur	14	3	1	0	1	5	19
New Orleans	13	3	5	6	1	15	28
Mobile	10	3	1	1	2	7	17
Tampa	4	3	0	4	1	8	12
Miami	2	2	0	0	1	3	5

Sources: [1] Spill Equipment Inventory System, U. S. Coast Guard.
[2] Personal communication with authorized personnel at Captain-of-the-Port/Marine Safety Office (COTP/MSO) in each area identified.

personnel must be well-trained in the use of equipment and the methodology of spill containment and cleanup. The most common products used for oil spill control and containment are such devices as booms, skimmers, sorbents, spill control chemicals (dispersants), and pumps.

Booms are: (1) floating barriers that are constructed in such a manner as to have significant freeboard and draft and are packaged compactly to allow for ease of transportation and deployment; (2) used to contain spilled oil for recovery, divert oil to areas where recovery is easily carried out, and used as a barrier in pathways to areas containing commercially valuable or environmentally sensitive resources; and (3) constructed of modern lightweight/high-impact materials (high strength to weight ratio), with a draft of 0.3-1.5 m and freeboard of 0.2-0.8 m.

Skimmers are those devices designed to remove a layer of oil from the water's surface for disposal. Most skimmers can be classified as weir skimmers (provides gravity drain off to oil), vacuum skimmers (similar to weir, but utilize a power source to actively remove the oil), centrifugal skimmers (where a power source is used to create a vortex that drains the oil into collection), submission skimmers (utilized by vessel by forcing the oil below the water level and using its buoyant property in the collection process), and oleophillic skimmers (collects oil on a moving sorbent material and mechanically squeezed it into collection areas). Skimmers typically have a recovery rate of up to 300 tons/hour, and skimming speed of approximately 1.5 kts, operable in a sea up to a maximum of 2-3 m and recovery efficiency of around 80%-90% in optimum conditions.

Sorbents are those materials that recover oil through absorption either on the materials' surface or collection of the oil in the materials' pores. Sorbents can generally be classed as natural organic material (cellulose, peat, or straw), synthetic organic substances (polyurethane, polystyrene, polypropylene, and rubber), and mineral-based compounds (ash, vermiculite, and perlite). They are also available in various sizes and shapes for particular usage requirements and they are available in rolls, sweeps, sheets, particulates, pillows, and booms.

The key components of chemical dispersants are surface active agents (surfactants) which are molecules that have both water-soluble (hydrophilic) and oil-soluble (hydrophobic) ends. These molecules, when applied to an oil spill, orient themselves at the oil/water interface such that the hydrophilic ends of the molecules are in the water and the hydrophobic ends are in the oil. The result is a reduction of interfacial tension between the oil and water. This action reduces the cohesiveness of the oil slick and, with agitation, finely dispersed oil droplets (ranging in size, depending on the effectiveness of the surfactant formulation, from about 10 microns to 0.5 mm in diameter) are formed in the near-surface water. The hydrophilic surfactant groups prevent droplet recoalescence.

The decision to use dispersants should be made as soon as possible after the spill incident. Weathering of oil will increase the viscosity and decrease the capability of chemically dispersing the oil. Factors to be considered in making this decision are oil type and properties, environmental conditions, the availability of dispersant and application equipment, and the probable fate of the oil without treatment. Highly viscous oils (greater than 5,000 centistokes), oils with pour points near or above ambient temperature, and oils with a high wax or asphaltene content may not be amenable to dispersant treatment (International Tanker Owners Pollution Federation, Ltd., 1982; Canevari, 1985). Dispersants are not recommended for use on spills on very calm waters. Some dispersants are formulated for use on marine (salt water) spills only.

Dispersants may be applied by boat or aircraft. However, both require spotter aircraft to direct operations. Boat application is limited to small spills or those within a few miles of shore. Aerial spraying is the preferred method. It offers rapid response, coverage of large areas per unit of time, good control of treatment rates, optimum use of dispersants, and much better evaluation of treatment results than is possible from boats. A portable system designed for the Hercules C-130 airplane appears to be the most efficient, although various aircraft including helicopters may be used if properly equipped. Regardless of the method used, the application system must deliver the proper dosage of dispersant in a uniform spray of droplets to the slick. Most oil slicks considered for dispersion will be 0.25 mm thick, or less (a 0.25 mm thick slick contains over 4,000 bbls per square mile of oil). The dispersant must penetrate the oil to reach the oil/water interface. The proper dosage of dispersant (5 gal/acre is an average amount, depending on the dispersant and the oil types) must be used to attain the maximum reduction of interfacial tension. Finally, some form of energy, e.g., wind, wave, or mechanical, must be applied to the oil/water interface to cause the dispersion of oil into the upper part of the water column. Newer types of dispersants require very little mixing energy. (For a detailed discussion on dispersants, see Appendix D of Final EIS 104/105).

Pumps are used in oil spill cleanup operations to transfer collected oil from a collecting device, such as a boom, to a vessel or facility for separation, reprocessing storage, or transportation to other facilities. Although specifications of the various pumps available are not relevant to this discussion, it should be recognized that these are fundamentally necessary equipment for cleanup operations.

Offshore containment/cleanup operations are major tasks requiring significant coordination and cooperation, transportation of large equipment, vessel support, aircraft support, set-up and maintenance of a command/coordination post in the field, and properly staged and available equipment. Often, the weather/sea conditions and crew fatigue become the critical factors during these operations. As the seas approach heights in excess of 5 ft, these operations become increasingly more dangerous and ineffective. The effectiveness of offshore containment/cleanup operations is, in general, marginally effective. It is possible, however, to contain a platform spill if environmental and logistical conditions are right. The effectiveness of this type of containment and cleanup operation is estimated to be approximately 5%-15% recovery.

Inshore containment/cleanup operations can be either large scale or moderately sized operations depending on the particular spill situation. If the task becomes large, it requires the same level of coordination and support as an offshore operation.

The Coast Guard's Gulf Strike Team has an Open Water Oil Containment and Recovery System (OWOCRS) which is a system capable of removing oil in seas to 5 ft and surviving a 10-ft sea. The OWOCRS is 612 ft long with a draft of 32" and a freeboard of 16" supported by 102 CO2 inflatable flotation buoys. A pump sled recovers oil via six weirs located in the middle of the boom, discharging collected oil into an appropriate holding area at a rate of up to 825 gallons/minute. It should be noted that deployment and operation of the OWOCRS system is a large-scale operation requiring proper staging equipment, transportation, and logistics planning. Two vessels and a collection barge must be available for system operations. The USCG Strike Team has a variety of other support equipment at their disposal (Mobile Command Post, Air Deliverable Anti-Pollution Transfer System (ADAPTS), and Dracone barge), as well as personnel that are well-trained in handling this equipment (Proceedings . . ., 1985).

Clean Gulf Associates' (CGA) fast response open sea and bay skimmer is a portable system, adapted for use on a work boat of approximately 100 ft in length. This system is designed as a low-volume recovery system capable of 190 bbls recovery; however, the tanks can be pumped to waiting barges if necessary. Maximum skimming speed is about 3/4 kts. This system is compact enough to be stored offshore on mobile drilling rigs for fast response. In addition, CGA has available a high volume open sea skimmer system; shallow water skimmer system; dispersant spray systems for boats, helicopters, and fixed wing aircraft; incinerator; radio communication system; mechanical bird scarers; a waterfowl rehabilitation station; and biological and chemical sampling equipment.

The high-volume open sea skimmer is designed for open sea skimming in seas up to 5 ft and in currents up to 1 kt relative to the skimmer. Maximum efficiency is obtained in the stationary mode with the skimmer anchored down current from a spill. Its usefulness in chasing spilled oil is limited and not recomended. The system contains two 512' x 72" booms with additional lengths of boom available.

The shallow water skimming system is a self-contained shallow water skimming vessel approximately 36 ft in length. Operations are limited to skimming in seas up to 2 ft with a maximum skimming speed of one knot and total holding capacity of 34 bbls of skimmed material on board. Auxiliary storage barges with a 50-bbl capacity are available for additional storage.

The effectiveness of a containment/cleanup operation in an inshore area largely depends on the unique physical characteristics of the environment and the area of the operation. The range of effectiveness is from marginally successful to successful.

c. Recent Important Accidents

The following information is presented to describe the occurrence and environmental impact of oil spills that have occurred recently in the Gulf of Mexico and associated environs. Descriptionof the actual environmental impact is presented as a record as opposed to predicted impacts.

Horn Island Spill, MS: The Horn Island Spill was of unknown origin and resulted in the discharge of approximately 3,000 gallons of heavy fuel oil into Mississippi Sound on December 4, 1984. It is believed that the spill was from a tanker. Some oil from the spill washed ashore on the northern portion of Horn Island which is a part of Gulf Islands National Seashore. Tar balls resulted and covered an area 3-4 yards wide along the high tide mark for a distance of 3-4 miles. By December 14, 1984, the U.S. Coast Guard reported the removal of 64 bbls (2,710 gallons) of oil and 140 bbls (5,950 gallons) of oiled sand. A total of $35,000 was spent in the cleanup effort with monies from the cleanup to be taken from the Oil Pollution Compensation Fund. No birds or vegetation were reported to have been damaged. The professionals contacted to obtain information concerning the Horn Island Spill reported a good cleanup.

Shell Pipeline Spill, LA (OCS): The Shell Pompano Pipeline Spill was discovered in Main Pass Block 73 on February 16, 1985, with an initial spill of 320-360 bbls. Another 50 bbls were released during the repair effort 24 as a result of pressuring the line to discover the leak. Of the total 410 bbls spilled, approximately 171 bbls were recovered.

The Louisiana crude oil came ashore on Grand Gosier, Curlew and Breton Islands. A little over three miles of beach were contacted, and the intertidal zone 3-4 yards wide was impacted along the beach. The most extensive contact was on Curlew Island where approximately one-half acre of *Spartina alterniflora* was oiled along the intertidal zone. This grass did not experience any mortality nor did the 70 yds^2 of grass contacted around two tidal pools on Breton Sound. No oyster beds were contacted.

Fish and wildlife resources impacted were limited to birds. Fourteen birds were found oiled by the spill toward the end of the first week, including ducks, gulls, and loons. A bird cleanup station was set up in Venice, Louisiana, and Alice Berkner, a nationally recognized bird cleaning expert, was on the scene to direct cleanup operations. One common loon and one gannet were cleaned; the loon survived but the gannet did not. Four additional dead birds that were probably involved in the spill (for a total of 18 birds) were found at the end of the cleanup. A species breakdown of the dead birds was not made, except to verify that none were pelicans.

The slick traveled approximately 25 miles and came ashore on the leeward side of the islands. Cleanup operations spanned 14 days and were accomplished under the management and direction of Shell Offshore Inc. Three spill contractors supplied manpower for skimmer operations and beach cleaning. The cleanup was monitored by the U.S. Coast Guard, Captain of the Port, New Orleans, Louisiana. Approximately 400 man-days of effort were expended to clean the three islands. Detailed cost of the cleanup is not available; the preliminary estimate is $530,000.

AMOCO Well Blowout - West Delta Block 90: On February 21, 1985, a well blowout occurred on an offshore platform being operated by AMOCO in the West Delta Block 90 area. Approximately 60 bbls (2,500 gallons) of Louisiana crude oil was spilled. Approximately 250 gallons of the dispersant COREXIT 9527 was reportedly used at the spill site.

The resulting slick traveled approximately 40 miles to the northwest and made landfall on the Louisiana coast in Lafourche Parish just west of Grand Isle. Approximately 5-10 bbls (420 gallons) of the original 60 bbls reached the beach. All oil was cleaned from the beach except one gallon. No impacts to wildlife, marsh vegetation, or oyster beds were reported. The case was closed by the U.S. Coast Guard on February 28, 1985.

The above information was obtained from the U.S. Coast Guard. There are inconsistencies between the U.S. Coast Guard and AMOCO accounts of the spill. AMOCO contends that there is no evidence that the slick traveled 40 miles and made landfall. Furthermore, AMOCO contends that approximately one gallon of crude oil was located in the mouth of a canal near the beach. AMOCO agreed to cleanup the one gallon of oil but claimed no ownership or responsibility for the spill.

Alvenus Oil Spill: On July 30, 1984, the British Tanker Alvenusœgrounded and cracked in the Calcasieu Ship Channel in the Gulf of Mexico 11 miles south of Cameron Parish, Louisiana, in West Cameron Blocks 31 and 62. It was reported to have spilled 45,000 bbls (2.27 million gallons) of heavy Venezuelan crude oil over the next few days. The oil stayed adrift in the Gulf, moving in a westerly direction until August 3-4, 1984, when it began to come ashore on the Texas beaches between High Island and Galveston's West Beach. By August 7, 1984, no slick associated with the *Alvenus* was evident in the Gulf.

Impacts to sensitive coastal habitats centered on the recreational beaches and coastal marshes in Texas. Approximately 100,000 yd^3 of oiled sands were removed from an 8-mile stretch of Galveston beachfront in a 110 ft wide strip about 5 inches deep. Bolivar Peninsula, specifically Rollover Inlet and Crystal Beach in Chambers County, was extensively oiled from the spill. Twelve birds of undetermined species were oiled resulting in five mortalities and seven being treated and released. One sea turtle of undetermined species was treated and released.

Cleanup lasted three to four weeks with the focus of effort on the tourist-related recreational beaches. Galveston beachfront owners filed a $100 million class action suit for damage compensation based on loss of income and expenses for cleanup. Very little oil was reported to have breached the beaches or entered the coastal marshes. The State of Texas, however, filed suit for compensation to damaged marshes and other resources.

South Florida Oil Spill: On January 18, 1985, a spill of approximately 175 bbls (7,500 gallons) of No. 6 heavy crude oil occurred from the cargo ship *M/V Nememcha*. The spill occurred during an oil transfer from one fuel tank to another approximately 30 miles south of Key West, Florida. The oil formed a slick 200 yards wide and drifted within 11 miles of Key West, then drifted into the Atlantic Ocean following the Florida current. The slick did not contact land or any coral reefs. No cleanup action was taken because the spill was predicted to drift into the Atlantic Ocean. No evidence of impact to sensitive coastal habitats was noted.

Padre Island National Seashore Drum Project: On January 7, 1985, a total of 141 drum containers were collected, sampled, and logged for content analysis from the Padre Island National Seashore. These drums are believed to have been "lost" overboard accidentally or deliberately. All of these containers were unmarked; some were rusted and therefore, the owners could not be identified. Containers that were corroded and leaking were stored in salvage drums to prevent contamination. The barrels washed up on the beach area extending from Port Mansfield to Matagorda Island. Of the 141 drums, 40 drums contained small amounts of barium, 29 contained barium and other chemicals, 34 were identified as non-hazardous, 11 were identified as hazardous liquids, and 27 contained other various chemicals. Peterson Maritime is the company that was involved in the cleanup activities. It is estimated that a total of $215,000 has already been spent for cleanup activities and the cost is estimated to rise to $250,000 before the cleanup is finished. Monies were taken from the "Superfund" account. The containers are presently waiting to be transported and disposed at an approved toxic management facility in Pecos, Texas. A Federal and State interagency task force is evaluating a future strategy for monitoring and removing 55-gallon drums washing ashore on South Texas beaches.

Since January 1985, a total of 31 additional drums have washed ashore. The drums, like the first group, are unmarked and rusted. This has been an on-going problem for years and is continuing. At present, it is not resolved where the drums are coming from.

Fire and Explosion - B Platform, High Island Block A-571: On February 21, 1985, a fire and explosion occurred from 7:30 p.m. until 11:00 p.m. at the CNG platform B located in High Island Block A-571. The automatic emergency shutdown valve shut in the well. There were 12 people on board platform B at the time of the explosion and 55 people were on board platform A. Workers were evacuated by a standby boat and one safety capsule, which is available at all times. A workboat and speedboat were in the area and were also used for the evacuation. A total of five people were injured and there were no fatalities. Of the five injured, four were evacuated by helicopter to a nearby burn center. The cause of the fire and explosion was determined to be a gasket failure on a 16-inch inspection plate for a high pressure separator. There was no pollution as a result of this accident, and personnel were back on board at 1:00 a.m. the next day.

Atchafalaya Barge Spill: On March 5, 1985, a Hollywood 2006 Barge, under tow, hit a submerged object which tore six holes in one tank of the barge. The object is unidentified at the present time. Approximately 500 bbls were spilled. The spiller deployed a 1,800 ft boom and was able to contain the spill. Peterson Maritime of New Orleans handled the cleanup. As of March 7, 1985, 75 bbls remained to be cleaned up. Cleanup activities continued 2-3 more days. There appears to be no ecological problems at this time despite the size of the spill. The monies for the cleanup were charged to the Coast Guard's Revolving Fund. At this time, the total cost of the cleanup is undetermined.

Green Canyon Block 254: On June 3, 1985, a supply boat was offloading diesel fuel to a drilling rig. The flow meter malfunctioned while the fuel was being pumped. The diesel backed up at the starboard loading line where a 6-inch valve remained open and spilled into the Gulf. Approximately 643 lbs were spilled. No cleanup was recorded.

Storage Tank, North Padre Island A-11: On July 30, 1985, a mineral oil storage tank was being moved by a crane. When the tank was lifted up, it parted at the seams and pollution resulted. Fifty bbls of oil base mud were spilled; the pollution dissipated.

Chandeleur Area Block 18: On September 4, 1985, a barge-loading hose was not secured well enough, and hurricane winds caused it to beat against the side of the platform and to rupture. The hose was connected to a 200-bbl condensate storage tank on the production deck. The leak was secured after the storm and the hose was replaced. Approximately 66 bbls were spilled. Cleanup was impossible due to rough weather.

West Cameron Block 421: On September 26, 1985, a crew was transferring diesel fuel from a supply boat to the rig. The transfer line burst and diesel spilled into the Gulf. Approximately 58 bbls were spilled. Clean Gulf Associates was the company in charge of cleanup. Most of the oil dissipated.

Helicopter Crash, East Cameron Block 215: On October 24, 1985, at 10:15 a.m., a Pumpkin Bell 222 helicopter rashed on platform A of East Cameron Block 215. At this time, the FAA is investigating the crash. No one on the rig was injured; however, two personnel on board the helicopter were killed and there were seven injuries. Burn victims were transported by helicopter to nearby hospitals.

Penrod Rigs 60 and 61, Grand Isle Block 86: Penrod 60 and 61 were drilling at a water depth of 250 ft on October 27, 1985. A tropical depression in the Gulf developed into Hurricane Juan with 50-60 mph winds and 20-30 ft seas. It intensified so quickly that personnel on many platforms and rigs could not be evacuated. After midnight, personnel on Penrod 60 called in a Mayday signal for Penrod 61. The legs were starting to collapse and 43 people were on board. Twenty-four people were evacuated into one of two Whittaker capsules and 19 in the other. The rig collapsed and floated toward the Penrod 60 rig. Personnel on Penrod 60, with 39 people on-board, were evacuated into a life boat and transported to another paltform when the hull of Rig 61 drifted near Rig 60. Twenty to thirty foot waves caused the Whittaker capsule with 19 people on-board to overturn. The capsule was evacuated and some people were able to hang onto the capsule until Coast Guard officials rescued them at daylight. One person died and there were several injuries. This incident is under investigation.

South Timbalier Block 86-A: The platform which was installed in 1956 is missing and was apparently blown over during Hurricane Juan (October 27-28, 1985). Production equipment on board is also missing. Five people were onboard and were evacuated safely. There was one producing well and six incoming lines from other wells or platforms. No pollution was observed.

OMB Complex, South Pelto Block 19: The header platform and the No. 2 well platform were knocked over during Hurricane Juan (October 27-28, 1985). The facilities on the main platform were damaged where the piping pulled out of the production equipment on the south end of the platform. The No. 2 well was under water and polluted slightly for two days. The slick was 100 yds long and 10 yds wide. On October 31, 1985, there was no pollution.

Pipeline Accident, Eugene Island Block 51A: On November 1, 1985, a pipeline leak was discovered in a 12" line located in Eugene Island Block 51A. The leak occurred as a result of damage from Hurricane Juan which hit the area on October 17-18, 1985. Fifty bbls were spilled and were cleaned up by Clean Gulf Associates. Pipeline operations are routinely shut down during hurricanes, and the leak was as discovered when pipeline operations resumed. A section of the riser and J2 section was replaced. In addition, a 51-foot spool section of new pipe was replaced and the pipeline was put back into service.

Sun Oil Company Well Blowout, West Cameron Block 648: On December 3, 1985, a gas well blowout occurred during workover operations. The well ignited on December 7, 1985, before an attempt could be made to cap the well or pump kill mud into the other producing wells on platform A. All personnel were safely evacuated with only minor injuries to three people from well control fluid blown out of the tubing. Fire destroyed the rig and production deck of the platform and two relief wells were drilled. The fire was extinguished on December 26, 1985, and was purposely reignited. It was finally extinguished on December 31, 1985; a blowout preventer was installed on January 2, 1986; cement was pumped down the well, essentially killing the well as of January 18, 1986.

The blowout was predominantly gas with minor amounts of condensate. Although a local light sheen was visible, pollution was minimal.

C. ITEMS OF SPECIAL CONCERN

1. Hazardous Conditions

Within the Gulf of Mexico major geohazards to oil and gas development are associated with seafloor geologic features which result in seafloor instability. These hazards present many operational limitations to the exploration and development of oil and gas. Seafloor instabilities present limitations and necessitate adaptations in the siting, structural engineering, and routing of pipelines, exploratory drilling and production platforms.
For greater detail of potential geohazards existing within areas of the Gulf of Mexico, see Volume 1, Section III.A.1. of the Final Regional EIS.

Under the schedule for oil and gas leasing, the offering of all blocks within the CPA and WPA does not allow for presale geohazard block evaluations that were previously done. Instead, the Secretary of the Interior has announced that geohazard surveying and evaluation will be done by industry. The Regional Director (RD) of MMS will notify the lessee through NTL 83-3 (Appendix B) that such conditions exist that precautions in site selection and design must be taken. Thus, industry has the responsibility to interpret in detail and furnish the RD with the results of surveys for the blocks leased within the geohazardous areas. Subsequently, industry must indicate to the RD how plans of exploration and development minimize and/or avoid the geohazards which exist within the lease area. Geological and geophysical (G&G) activities authorized under 30 CFR 251 must be conducted so that the activities permitted do not create hazardous or unsafe conditions. G&G activities provide data on potential geological and man-made hazards. Geophysical surveys conducted on a lease must be conducted in compliance with NTL 83-3, Shallow Hazards Requirements for the Gulf of Mexico OCS Region. Prior to the installation of any structure or pipeline, the grantee shall conduct a shallow hazard analysis in the immediate area of the proposed activity to locate, identify, and assess the potential geologic hazards and engineering constraints that may be present.

In essence, a shallow hazards analysis shall include the following:

- An assessment of any seafloor and subsurface geologic and man-made features and conditions which may have an adverse effect on the proposed operations. Seafloor geologic hazards include fault scarps, gas vents, unstable slopes, and reefs. Subsurface geologic hazards include faults, gas-charged sediments, abnormal pressure zones, and buried channels. Man-made hazards include pipelines, wellheads, shipwrecks, ordnances, communication cables, and debris from previous oil and gas activities.
- A specific discussion of mass movement of sediment, unstable slopes, active faulting, or gaseous sediments when required by the special operational constraints on some leases.
- A discussion of any special safety measures that would minimize the effects of shallow hazards on the proposed pipeline including a discussion of how compliance with provisions of NTL 83-3, Section IV, paragraph B, will be accomplished.

Under the postsale regulatory authority of MMS the lessee is required to obtain detailed site-specific geologic hazards information, including soils borings in special cases, over locations on leased blocks where pipeline development is proposed. This mandatory requirement is imposed on all lessees to assure safety of operations prior to approval of pipeline permits. The extent and degree of geologic hazards investigation required of the lessee is at the discretion of the appropriate RD, who is charged with approval of the safety of OCS operations. The general procedures to be followed by the lessee in conducting site-specific geologic hazards survey are set forth in NTL 83-3 issued by MMS. The NTL and applicable letters to the lessee serve as guidance for minimum requirements and in no way restrict the authority of the RD to impose additional requirements on the lessee when necessary.

2. Ordnance Disposal

The Department of Defense's (DOD) explosives dumping areas found in the Gulf planning areas are shown on Figure I-5. Most of the small areas contain a single, undetonated depth charge. For the large areas shown, dumping consisted of old ordnance and unexploded (duds) shells and depth charges. All explosive areas have had no dumping activities since 1969-1970. However, all lessees should take precautions in drilling and locating structures within or near these areas due to the presence of unexploded ordnance. The U.S. Air Force (USAF) has released an indeterminable amount of unexploded ordnance in water test areas 1 and 3 as a result of testing and training missions. The exact locations of this unexploded ordnance cannot be determined and all lessees in the Gulf should take precautions in drilling or locating structures due to the potential that exists. In past sales this warning has been provided to each lessee in an ITL (Information to Lessees).

3. Blowouts

During oil and gas operations on the OCS, blowouts are the incident that is most feared and has the greatest potential for causing the greatest number of deaths, injuries, property damage or loss, and pollution. A blowout is considered a complete loss of well-control. However, well blowouts and platform or drilling rig losses are rare occurrences during offshore drilling operations.

Two substances can be responsible for the pressures which cause a blowout--oil and gas. Very shallow gas may occur in unconsolidated sediments at depths of 100-500 ft below the mud line. Drilling through these shallow gas zones requires extreme caution. A delicate balance between drilling-mud pressure and formation pressure is necessary to prevent an influx of gas into the wellbore and not fracture the near-surface formations. Shallow gas and formation fracturing is an even greater potential hazard in deep waters because it is more difficult to keep in proper balance with the ocean water and overburden pressures.

When a well blowout occurs, the loss of control could be momentary and control could be immediately regained using standard onsite safety equipment and procedures, or it may continue for several days. The duration of blowouts that occurred in 1979 through 1984 ranged from immediate shut-in to 57 days to regain control. The amount of pollution per blowout ranges from 1-64 bbls (Table IV-26). Since 1970 no oil spill of 1 bbl or more has occurred as a result of a blowout during drilling operations. In addition, the amount of oil pollution during blowouts has been decreasing. The amount of gas escaping during a blowout is difficult to determine; however, no identifiable environmental damage was caused by blowouts from 1979-1984.

Industrial expertise in safety has been increasing as industry has advanced drilling technology. MMS is supporting studies on blowout prevention, blowout fire suppression, and the collection of blowout oil before it disperses into the open ocean. An important factor in ensuring that offshore oil and gas operations are carried out in a manner which emphasizes safety of operations and minimizes the risk of environmental damage is the proper training of personnel in pollution prevention procedures. The enacted Safety Device Training Program requires all personnel to receive training for the installation, testing, inspection, and operation of production, safety, and pollution prevention equipment. The Well-Control Training Program was instituted by MMS in 1979, requires all personnel involved in offshore drilling activities to be trained in well control operations, and has requirements for periodic refresher courses.

D. ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTIONS AND ALTERNATIVES

1. Central Gulf Sale 110

a. Impacts from Alternative A - The Proposed Action

(1) Impacts on Sensitive Coastal Habitats

The following five levels of impact are used in the analyses and conclusions that are subsequently discussed (the numbers in parentheses refer to the number of oil spills of 1,000 bbls or more contacting wetlands):

Very High	- Very severe long-term adverse effects: more than 2% of the habitat area destroyed or altered; or loss/interference due to oil spill contacts with sensitive coastal habitats (4 or more).
High	- Major long-term adverse effects: 1%-2% of the habitat area destroyed or altered; or loss/interference due to oil spill contacts with sensitive coastal habitats (2-3).
Moderate	- Moderate adverse effects: 0.25%-1% of the habitat area destroyed or altered; or loss/interference due to oil spill contacts with sensitive coastal habitats (1).
Low	- Minor adverse effects: 0.02%-0.25% of the habitat area destroyed or altered; no spill contacts with sensitive coastal habitats.
Very Low	- Negligible to minor adverse effects: 0.02% or less of the habitat area destroyed or altered; no spill contacts with sensitive coastal habitats.

The major impact producing factors which could potentially affect sensitive coastal habitats are: oil spills, pipeline emplacement, construction of onshore support facilities, navigation canals, and maintenance dredging. An oil spill coming into contact with these habitats could cause relatively long-term damage. Important variables determining the degree and impact include the amount, toxicity, and the degree of weathering the crude has undergone prior to contacting a habitat, habitat type contaminated by the crude, the climate and weather of the spill site, the water depth and suspended sediment load, the cleanup method attempted, and previous exposure to oil spills.

For this analysis the assumption is made that onshore emplacement of one mile of pipeline could alter or destroy up to 12 acres of habitat. The recovery of these habitats from pipeline emplacement varies from complete to none depending on many factors, including degree of disturbance, location, substrate, species, season, and hydrologic factors. The push ditch method of pipeline installation is presently stipulated by the State of Louisiana and is

Table IV-26

Blowouts in the Gulf of Mexico, 1979-1984

Year	Drilling, Exploration, and Development	Nondrilling, Completion, Production, and Workover	Total Blowouts	Pollution	Deaths/Injuries	New Wells Started
1979[1]	5	0	5	0	8/9	1,109
1980[1]	4	4	8	1 bbl*	5/39	1,079
1981[1]	3	7	10	65 bbls*	7/4	1,106
1982[1]	4	4	8	0	0/7	1,155
1983[2]	8	3	11	0	0/2	981
1984[2]	3	1	4	0	4/3	1,163

*Occurred as a result of a nondrilling event.

[1] U. S. Geological Survey Open File Report 83-562, August 1983 (Fleury, 1983).
[2] Minerals Management Service Events File and Quarterly Reports, 1983 and 1984.

For information on blowouts prior to 1979, see U. S. Geological Survey Open File Report 80-101 (Danenberger, 1980).

preferred by most pipeline permit applicants in the absence of stipulations. This method involves excavation of a trench, placement of the pipe in the trench, and placement of excavated soil back into the trench. Depending on substrate, salinity, and hydrology, the wetland vegetation may reestablish naturally. In some situations, restoration is stipulated by the regulatory agencies. In some cases, the wetlands erode and are lost.

The following estimates of the maximum acreage used for new onshore infrastructure/support facilities in the CPA are considered in the analysis: exploratory drilling service base - 15 acres; development/production service base 5-25 acres; pipeline installation service base - 5 acres; pipe coating yard - 30-60 acres; pipelines per mile - 3-12 acres; platform fabrication yard - 20-400 acres; gas processing plant - 40-60 acres; and marine terminal - 20-30 acres.

(a) Barrier Beaches/Islands

The Gulf of Mexico's barrier environments are rich in ecological, recreational, and commercial values; however, they are continually subject to numerous competing pressures for the use of their valuable resources. Conflicts threaten to seriously degrade these environments both in their role as ecosystems and as sites for potential human development and activity. In their undisturbed state these systems are highly resilient, but despite their capacity to adjust, they can be easily damaged or altered by human activities.

The general characteristics of coastal barriers are shaped by: (1) the energy regime; (2) the dynamic equilibrium of sediment deposition and erosion; (3) world-wide sea level fluctuations; and (4) subsidence of the continental margin. The interaction of these processes influences both the shape and location of coastal barriers. Allowed to function naturally, these processes ensure the continued maintenance of the coastal barrier system. Alteration of these processes through man's intervention reduces the system's ability to adjust to daily, seasonal and storm processes, that in turn can destroy the human structures located on barriers, the wildlife utilizing these systems, and the coastal barrier itself (Brower et al., 1976 in USDI, 1985).

Impact Analysis

The major impact producing factors which could potentially affect the Gulf's barrier beaches, in association with OCS activities in the Central Gulf, include pipeline emplacement, support infrastructure construction, oil spills, construction and maintenance of navigation canals and offshore debris. The latter topic will be discussed in Section IV.D.1.a.(8) under Impacts on Major Shorefront Recreational Beaches.

As a result of the anticipated leasing activities associated with lease Sale 110, up to three pipeline landfalls are estimated for the Central Gulf. The greatest potential for impact resulting from pipeline emplacement and landfall on barrier beaches would occur in coastal subarea C-2. Within this coastal subarea C-2 (St. Mary, Terrebonne, Lafourche, and Jefferson Parishes, Louisiana), up to one oil/gas transmission pipeline and landfall is estimated. Based on two possible routing scenarios, a pipeline from the Federal OCS could cross the Isle Dernieres in Terrebonne Parish and terminate in the vicinity of Dulac, Louisiana, in the same parish, or cut across Timbalier Island in Terrebonne Parish and terminate at Golden Meadow in adjacent Lafourche Parish. The first scenario could alter up to 9.2 acres of barrier beach habitat, while the second one would alter up to 13.8 acres of habitat. The maximum represents an alteration of 0.09% of these habitat types within coastal subarea C-2.

The pull method is the basic pipeline installation technique permitted on barrier beach systems. Land excavation equipment, usually backhoes, would be used to dig a trench onshore and in some instances sheet piling would be used to line the trench, allowing excavation of a narrow and stable trench to any desired burial depth. This practice is useful in situations where the sediments' angle of repose and degree of saturation would necessitate the excavation of a considerably wider trench or where it is desirable to disturb only a small area to limit potential environmental impact. The nearshore section of the pipeline would be either pre-excavated by barge mounted clamshell or dragline dredges, or buried after installation by submarine trenching machines. In water depths too shallow for barge operations, land based equipment would be used (Golden et al., 1980).

The construction trench through the beach would result in short-term, localized changes; however, that portion of the trench that is cut through the dune ridge could create a major zone of environmental disturbance. This area is a zone of potential instability and in the landform/vegetation complex that often is difficult to restore. Adverse impacts to this area could be ameliorated through the implementation of rigid construction practices and proper scheduling, the employment of mitigating measures, and the restoration of the dune system. Construction through dunes could result in the future breaching of the entire dune complex and adversely affect those areas protected by the dunes. Breaching of any barrier beach/island would occur at weak or sensitive points (disturbed, nonvegetated, or low areas); therefore, the location at which a pipeline is constructed through an altered beach-dune complex would become a point for breaching during a hurricane or severe storm. The potential exists for these storms to expose pipelines by subjecting them to extreme tidal and scouring action (Golden et al., 1980).

In order to minimize potential impacts resulting from pipeline emplacement across the systems, a number of considerations should be addressed prior to construction. These include the environmental sensitivity of the affected coastal systems, present and future use of the landfall and right-of-way areas, governmental regulations or ordinances, and requirements or stipulations included in rights-of-way negotiations.

Within the foreshore region, the pipeline trench will be refilled using original material and all sheet piling will be removed, where used. The beach is graded to return the area to its original contours, and although the aesthetic recovery of the beach is relatively quick, the beach may be vulnerable to wave attack and erosion until natural resorting restores the beach sediments back to equilibrium. The primary concern with the dune restoration phase is to insure its return to the natural protective function of sheltering the backshore wetlands or other environments from direct attack from storm waves and saltwater inundation. After refilling the trench, the dune is restored to its original elevation and replanted with vegetation similar to that of the surrounding dunes. Where seasonal conditions do not permit immediate replanting, netting, thatching, or sand fencing may be used as anti-erosion devices until replanting can commence. Temporary roads and paths are removed and natural drainage patterns are usually restored to the extent possible.

Terrebonne, Lafourche, Jefferson, and Plaquemines Parishes contain barrier beach systems which are exposed and highly vulnerable to potential oil spills resulting from the proposed action. One large spill (1,000 bbls or greater) is assumed for analysis purposes, and although the probability for a contact is less than 10%, in the event a spill were to contact the severely eroding barrier beach network in south Louisiana, high to very high impacts could result depending on the volume of oil contacting a particular area, the time of year, and water stages. Clean-up activities could result in the removal of large volumes of beach sands from the beach front and dune areas, resulting in a loss of greater than 2% of the existing barrier habitats within this region. Aside from the fact that sand would be removed from the area, it is assumed that heavy equipment would be needed for clean-up activities of this nature, thereby altering beach and dune habitat areas adjacent to the contact site. As a result of the low relief of most of these areas, in the event a spill were to occur during high water or storm conditions, the impacts could be more extensive. This may include damaging habitats that exist on the backshore and bay areas, most of which consist of salt marsh habitats, or transporting the oil directly into the bays and estuaries adjacent to these landforms.

The long-term behavior of barriers beaches, islands, etc., depends principally on the rate of sea level rise, sand supply, sea energy, and human intervention. Sand supply is often the key to a barriers evolution, and with a constant supply of this material, they can maintain themselves in place. However, due to the dwindling sand supplies in the Louisiana coastal region, removal of contaminated sand material during spill clean-up operations could result in accelerating the current rates of erosion within these areas, if not replaced by a clean sand source soon after the material is removed from the site. It is unlikely that such a technique would be utilized due to the remoteness of many of these areas, with the exception being Grand Isle, Louisiana. In most instances the majority of the surface oil would be soaked up using absorbent pads and leaving the remainder of the oil to weather on the beach. Clean-up activities would be coordinated with State officials, as to the method of clean-up to be utilized.

No new ancillary facilities or new navigation canals are expected to result from the proposed action. However, maintenance dredging of existing navigation canals will occur periodically and this in itself interferes with the dynamics (littoral system) of such a complex, endangering the natural deposition of sand/sediment and the self maintenance of its features.

Conclusion

As a result of the proposed action, the level of expected impact on barrier beaches/islands is estimated to be low in coastal subarea C-2 and very low in the rest of the CCA. The level of impact to the CCA will be low.

Cumulative Impacts

Oil/gas exploration and production activities in the Central Gulf will contribute to the cumulative impacts on barrier beaches within this region. These activities, along with current and future activities in association with State tidelands' oil and gas operations, construction and development within the coastal zone, beach protection and stabilization projects, recreational-use pressures, and natural events, are among the contributions to the overall cumulative impacts on barrier beach/island systems.

Approximately 70 platforms (multiwell) are currently operating in the Central Gulf State waters (1985). An unknown number of additional structures may be constructed as a result of resource development in State-owned coastal waters. The construction of several additional pipelines from existing lease blocks in both Federal and State waters may occur in the future as a result of increased development activities in these areas. Pipeline-related activities resulting from prior OCS sales could result in the alteration of barrier habitats from the addition of up to 14 new pipeline landfalls (C-1 (4), C-2 (5), C-3 (4), C-4 (1)) and up to 280 miles of pipeline as a result of the proposed action, and future and prior OCS sales in the CPA. Twenty-three large oil spills (1,000 bbls or greater) and numerous smaller spills resulting from Federal offshore and import tankering activities are assumed for analysis purposes. Land segments with the highest probabilities of contact from these include Terrebonne (83%), Lafourche (75%), Jefferson (45%), and Plaquemines (89%) Parishes in the CPA and Galveston County (57%) in the WPA. These areas have the greatest potential for receiving high to very high impacts to barrier beach systems in the event a spill or several spills were to contact these.

With land loss rates in coastal Louisiana exceeding 50 mi^2/yr., preservation of the Central Gulf's (Louisiana's) barriers and shorelines has become of increasing concern. Between 1880 and 1980, the total coastal barrier area decreased from 98.6 km2 to 57.8 km^2, an overall loss of 40% (Penland and Boyd, 1982). These barriers serve to protect the State's vast interior wetlands from direct attack from storm waves and saltwater intrusion.

The three primary causes of coastal barrier erosion and land loss include: (1) reductions in sediment supply; (2) relative sea-level rise; and (3) human activities. Although listed separately, the third category directly affects the other two. Of foremost importance is the natural decrease in sediment supply that accompanied climatic changes over the past few thousand years. The major coastal rivers and nearshore currents are no longer delivering the volume of sediment that they once did. This natural decrease in sediment supply has been aggravated to varying degrees by dam construction and entraining of rivers, and emplacement of jetties, groins, and seawalls that compartmentalize the coast and disrupt the longshore transport of sand. These structures have locally contributed to shoreline erosion and their contribution to land loss may be even greater in the future (Morton, 1982).

Relative sea-level rise refers either to rising of the water level or sinking of the land surface; both processes produce the same effect and both may act simultaneously, with the end result being that the land becomes submerged and the shoreline retreats inland. Along the Texas and Louisiana Gulf coast relative sea-level rise in recent years averaged between 0.5 and 1 m per century (Hicks, 1972). Again, both natural processes and human activities are involved.

Serious attempts to stabilize the Gulf shoreline, especially at harbor entrances, began in the mid-1800's when safe navigation into the shallow bays was becoming important to the coastal economy. Perhaps the most famous structure is the Galveston seawall that was erected to prevent overwash and flooding from storms such as the 1900 hurricane that claimed more than 6,000 lives (Morton, 1982).

There are two approaches to beach protection and shoreline stabilization: rigid structures, such as jetties, and nonrigid techniques, such as artificial beach nourishment. The rigid devices fall into two basic categories: structures to trap longshore transport of sand (e.g., groins and jetties) and structures to prevent the erosion of the shoreline (principally with seawalls). Groins, seawalls, and other engineering devices are designed to impede natural oceanic currents and sand transport. Due to the high cost of emplacement, these rigid structures are used only in localized areas to protect urbanized development in hazardous areas (Leatherman, 1982).

Rigid engineering structures have often produced poor and, in some cases, deleterious results. Large amounts of money have been spent on structures designed to save the beach, but many are ineffective and some have aggravated existing problems. Except for the Galveston, most concrete shoreline protection structures erected on the Gulf coast in recent years have failed or have been severely damaged. These structures have finite lives, are expensive to construct and maintain, and they commonly transfer the erosion problem elsewhere by locally eliminating the sediment supply. Nonrigid techniques do not interfere greatly with natural processes, although there are some problems associated with dune stabilization (Morton, 1982).

Artificial beach nourishment is probably the most effective way to deal with beach erosion problems. Sand is supplied to the beach at the same rate that it is naturally being lost alongshore or offshore. The problem is in being able to locate nearby sources of unpolluted sand of the correct size. Attempts to stabilize highly dynamic barrier islands will ultimately fail as sea level continues to rise. While engineering structures may be successful in localized areas for the short term, long-term problems are ultimately created, and substantial, continuing maintenance costs are incurred with this approach.

In spite of inherent hazards, there has been a boom in barrier island construction during the past few decades. A recent USGS study showed that urbanized land on barrier islands increased 152% between 1950 and 1973. When stable features such as buildings and roadways are built on dynamic surfaces in highly vulnerable positions, heavy damage can result from direct wave attack, overwash and flooding. The leveling or relocation of the barrier dune reduces the island's resiliency to oceanic forces. As the barrier retreats, these stable structures face the impact of the high energy swash/surf zone (Leatherman, 1982).

Recreational pressures on coastal ecosystems have greatly increased as well. The impacts include pedestrian trampling, off-road vehicle (ORV) traffic, and the degree of impact depends upon the type of use and susceptibility of the system being affected. Each natural system has its own level of tolerance, and this sensitivity must be determined in order to devise management strategies for alleviating or minimizing impacts. Most coastal ecosystems are adapted to severe environmental conditions and are not fragile in the usual sense. Stresses to these ecosystems include large variations in temperature, salinity, moisture, burial by sand, and saltwater flooding. These ecosystems are fragile only in the sense that the new stresses being applied by man are too severe (Leatherman, 1982).

The impact of natural events (storms and hurricanes) on natural resources is often overlooked due to the focus on economic losses resulting from these events. In 1985, three hurricanes severely damaged Louisiana's coastal barrier systems an shorelines. Hurricane Elena (September 1985) caused severe erosion and land loss along the Chandeleur Islands, where approximately 20% of the land area was lost. Elena eroded 25-80 ft of beachfront and breached the islands in several locations there. Hurricane Danny (August 1985) eroded approximately 10%-15% of the Isle Dernieres and cut several tidal channels through these islands. Beaches were eroded some 30-100 ft along these islands. Timbalier Island incurred similar damage to its shoreline. Grand Isle experienced erosion of 20-60 ft of beachfront. Hurricane Juan (October-November 1985) caused the heaviest damage to the State's barriers and shorelines by making landfall and lingering off/on the Louisiana coast for three days, resulting in extensive land loss and loss of fish and wildlife habitat. Beaches eroded 40-100 ft along the entire coastline, with some areas experiencing more extensive loss of beachfront. Channels through the barrier islands were widened and numerous new inlets were created (Louisiana Geological Survey, 1985).

Conclusion

The overall cumulative level of impact to barrier beaches/islands is estimated to be very high in the CCA.

(b) Wetlands

The wetlands considered in this analysis include forested wetlands, non-forested wetlands or tidal marshes, and mangroves.

In the analyses that follow, the Central coastal subareas (Figure IV-1) are used as the basic geographic unit for estimating and describing impacts. Factors resulting from the proposed action which could have impacts on wetlands are oil spills, pipeline placement, canal dredging, and construction of onshore facilities in wetland areas (Sections IV.A.4. and IV.B.). Each of these factors is considered in the impact analyses, and an overall expected level of impact is estimated for each affected coastal subarea using the five levels of impact as previously defined.

Impact Analysis

Cameron, Vermilion, Iberia, St. Mary, Terrebonne, Lafourche, Jefferson, Plaquemines, St. Bernard, Orleans, and St. Tammany Parishes contain non-forested wetlands that could be exposed to potential oil spills (Visual No. 14, Final EIS 94/98/102). An oil spill coming into contact with wetlands could cause devastating and relatively long-term damage (1-3 years). Important variables determining the degree and impact include the amount and toxicity of the crude, the degree of weathering the crude has undergone prior to contacting a wetland, wetland type contaminated by the crude, the climate and weather of the spill site, the water depth and suspended sediment load, the cleanup method attempted, and previous exposure to oil spills. The probability of one or more oil spills occurring and contacting wetlands in Louisiana parishes range from a high of 9% in Terrebonne Parish to 0.5% in St. Mary Parish, indicating that the possibility of a spill contact is low. About 116 miles of non-forested coastal wetlands occur in Terrebonne Parish and about 76 miles (66%) of these wetlands would be exposed to potential oil spill contact. Terrebonne, Lafourche, and St. Bernard Parishes contain mangroves which could be exposed to potential oil spills (Visual No. 14, Final EIS 94/98/102). The probability of oil spill contact with mangroves is about 12%; therefore, the occurrence of a spill contact is low.

One oil/gas pipeline is estimated for coastal subarea C-1 (Cameron, Vermilion, and Iberia Parishes, Louisiana). This pipeline could be routed in the vicinity of Johnson Bayou (Cameron Parish) or Pecan Island (Vermilion Parish). Numerous canals/waterways exist from the coastline to Johnson Bayou and in the coastal area below Pecan Island; consequently, if these routes are followed, little impact will occur to wetlands. If these routes are not followed, up to 12 acres of wetlands could be altered or destroyed in the Johnson Bayou route and up to 72 acres in the Pecan Island route. No other onshore facilities are estimated for coastal subarea C-1. Therefore, a maximum of 72 acres of coastal wetlands could be altered or destroyed for a loss of less than 0.01% of these habitats in subarea C-1.

In coastal subarea C-2 (St. Mary, Terrebonne, Lafourche, and St. Charles Parishes, Louisiana), one oil/gas pipeline is estimated. This pipeline could be routed in the vicinity of Patterson (St. Mary Parish), Dulac (Terrebonne Parish), or Leeville (Lafourche Parish). A pipeline to Patterson could damage or destroy up to 168 acres of wetlands; a pipeline to Dulac up to 144 acres of wetlands; and a pipeline to Leeville up to 60 acres of wetlands. Therefore, a maximum of 168 acres of coastal wetlands could be damaged or destroyed for a loss of about 0.01% of these habitats in subarea C-2.

In coastal subarea C-3 (Plaquemines, St. Bernard, Orleans, Jefferson, Tangipahoa, and St. Tammany Parishes, Louisiana), one oil/gas pipeline is estimated in the vicinity of Grand Isle (Jefferson Parish), Buras (Plaquemines Parish), or Yscloskey (St. Bernard Parish). There are enough canals/waterways at all three locations that few coastal wetlands impacts would occur provided these routes are followed. If they are not followed, up to 12 acres of wetlands could be altered or destroyed by the Grand Isle route; up to 96 acres by the Buras route; and up to 180 acres by the Yscloskey route. Therefore, a maximum of 180 acres of coastal wetlands could be altered or destroyed for a loss of about 0.02% of these habitats in subarea C-3.

In coastal subarea C-4 (Hancock, Harrison, and Jackson Counties, Mississippi; and Mobile and Baldwin Counties, Alabama), no pipelines are estimated. One service base is estimated which could result in the alteration or destruction of about 25 acres of coastal wetlands for a loss of about 0.02% of these habitats.

No new navigation canals are expected to result from the proposed action. Maintenance dredging of existing navigation canals occurs periodically; the amount associated with offshore oil/gas activities cannot be quantified. However, dredging does cause extensive damage to wetland areas and is discussed further under cumulative impacts.

Offshore-related facilities construction must comply with pertinent Federal, State, and local regulations and permitting procedures. These regulatory procedures implement environmental policies which seek to avoid or mitigate adverse impacts. This analysis assumes that these policies and regulatory procedures will be moderately successful in effectively mitigating adverse effects on coastal wetlands that could occur as a result of the proposed action.

Conclusion

The level of expected impact on coastal wetlands is estimated to be low in coastal subareas C-1, C-3, and C-4, and moderate in coastal subarea C-2. Overall, the level of impact on coastal wetlands in the CCA resulting from the proposed action is estimated to be low.

Cumulative Impacts

Wetlands loss has been and continues to be of concern in many areas of the Gulf Coast from Texas to Florida. In the Mississippi Deltaic and Chenier Plains of Louisiana, the rate of wetlands loss is very high. Gagliano (1981) estimated that the annual wetlands loss in 1980 in the Mississippi Deltaic Plain of Louisiana was 39.4 square miles (25,216 acres). During the period 1952-1974, the average annual rate of wetlands loss in the Chenier Plain was estimated at 7.7 square miles (4,928 acres) (Gagliano et al., 1981). The current estimated collective rate of wetlands loss for the Mississippi Deltaic Plain and the Chenier Plain is 50 square miles (32,000 acres) per year (Boesch et al., 1983). (See Appendix E for further discussion of wetlands loss.)

In addition to the impacts described for the proposed action, the following other major impact producing factors and expected impacts are considered in relation to coastal wetlands. The major factors are sedimentation, submergence, canalization, land surface development, and miscellaneous onshore activities.

Sedimentation, which under natural conditions would offset wetland loss, is declining. Sediment deprivation is primarily the result of a decrease in sediment load in the Mississippi River, the prevention of overbank deposition and crevassing, and the confinement of Mississippi River flow to main channels. Tuttle and Combe (1981) indicate that the modern suspended sediment load of the Mississippi and Atchafalaya Rivers has decreased by 50% since 1950.

Submergence of the wetlands is influenced by the rate of rise in sea level and subsidence of the land. Most experts agree that the rate of global rise in sea level slowed considerably about 5,000 to 7,000 years ago when most of the continental ice sheets had melted. During this century, however, the rate of rise of sea level has increased to 12 cm/century (Gornitz et al., 1982). Geologic studies indicate that prior to about 5,000 years ago, submergence rates were occurring too rapidly (25 cm/century) for wetlands to persist in the coastal areas (Coleman and Smith, 1964). The submergence rate at which wetlands deteriorate is variable depending on local sedimentation rates. Delaune et al. (1983) estimated the submergence rate in Louisiana at 1.2 cm/year. Submergence is also affected by geosynclinal downwarping, compaction, dewatering, flow of recent sediments, and fluid withdrawal (hydrocarbons and water). The contribution that each of these processes makes to subsidence has not been quantified.

The impacts of canals on coastal wetlands include both direct and indirect impacts. The direct loss of wetlands associated with oil and gas development results from dredging activities, dredged material disposal, and canal widening. Indirect losses result from hydrologic changes that develop in wetlands after canalization has occurred. Turner et al. (1982) estimated that canals accounted for 2.4% of the coastal area in 1978. The cumulative linear extent of canals was estimated at 4,573 miles in 1970 (Barrett in McGinnis et al., 1972) and 6,100 miles in 1984 (U.S. Army Corps of Engineers, 1984b), an increase of about 1,527 miles of canals in 14 years. Canals widen through use, generally as a result of wave action and altered hydrologic patterns. According to Craig et al. (1979), the annual increase in canal width ranges from about 2%-14% per year for a doubling time of 5-60 years. Variability in widening rates is associated with firmness of the marsh substrate and the amount of traffic in the canal (Johnson and Gosselink, 1982).

Indirect impacts of canalization affecting wetlands loss include hydrologic interruptions and saltwater intrusion. Scaife et al. (1983) indicate that hydrologic interruptions created by spoil banks are a primary factor affecting wetlands loss. Intersecting spoil banks partition areas of marsh and impede drainage. Poor drainage is deleterious to plant survival (Mendelsohn et al., 1981), and as vegetation in impounded areas dies, ponds appear.

Canals act as conduits for the inland movement of saline water. Saltwater intrusion kills salt intolerant plants, thereby contributing to wetland deterioration. Saltwater intrusion is damaging to freshwater wetlands, especially to "flotant marshes" which lack a firm subsoil and consist entirely of salt intolerant vegetation. Plant species in brackish marshes can tolerate higher salinities and may not be severely damaged by an increase in ambient water salinity.

Estimates of the contribution of canalization to wetlands loss vary. Turner et al. (1982) estimates that 10% of the coastal land loss in Louisiana is caused by the direct impacts of canals and as much as 80% by indirect impacts. Most estimates of wetlands loss from direct and indirect impacts combined range from 12%-65% as indicated below:

Author	Estimated Percent of Wetlands Lost Through Direct/Indirect Effects of Canalization
Manning, 1972 (in McGinnis et al., 1972)	12%
Deegan et al., 1979	33%-67%
Gagliano, 1973	45%
Craig et al., 1980	20% (direct loss in Barataria Bay)
Scaife et al., 1983	48%-97%

Based on available information, there is sufficient evidence to assume that sedimentation and submergence processes are more important than canalization in wetlands loss in coastal Louisiana. On the Mississippi River Delta, Wells et al. (1983) have documented that the growth and decay of subdeltas and associated wetlands near the mouth of the modern main channel of the river occur in cycles of about 100 years. These cycles are associated with natural processes, such as crevassing, channel extensions, channel abandonments, and subsidence, and appear to occur independently of canalization activity. Cleveland et al. (1981) have used simulation models to demonstrate that if sediment from the Mississippi River were reintroduced into the Barataria basin, an area with an extensive canal network and severe land loss, the basin would experience net wetlands gain during the next century.

Furthermore, wetlands loss is occurring in other estuarine and deltaic areas where oil and gas activities and canalization are not occurring such as in the Chesapeake Bay (Kearney et al., 1983; Pendleton and Stevenson, 1983) and in Texas on the Colorado (Kanes, 1970) and Guadalupe (Donaldson et al., 1970) River Deltas.

Some indication of the extent of oil and gas activities for the development of onshore resources within the Louisiana coastal area is indicated by the onshore production data for 1954-1982. Cumulative production from the Louisiana coastal area amounted to 9.9 billion bbls of oil and condensate and 80.4 tcf of gas, which, by comparison, exceeded production from the Federal OCS by 72% and 50%, respectively. Furthermore, during the period of greatest State production, the open-ditch or "flotation" method was used for pipeline installation. This method involved dredging canals 40-50 feet wide, and 6-8 feet deep, often with an additional trench in the bed of the canal to provide 10-12 feet of clearance above the top of the pipeline. The dredge spoil was piled in levees along the edge of the canal (McGinnis et al., 1972). The flotation method is very destructive to wetlands because of the large size of the canals and the associated prominent spoil banks. Since the early 1970's, the "push" method of installation has been used. The "push" method involves a much smaller ditch than the "flotation" method, and the dredged material is usually replaced into the ditch (a process called "backfilling") so that open ditches remain less frequently after completion.

No information is available on the total number or miles of pipelines installed in the coastal area. Since the beginning of the Federal oil and gas program in the Gulf of Mexico OCS region, approximately 135 pipelines have been installed from the OCS to the shoreline (1951-1983). Of these landfalls, approximately 127 are in Louisiana, 1 is in Mississippi, and 7 are in Texas (USDI, MMS, 1984d). Limited information is available on the number and locations of pipelines that originate in State waters and the onshore coastal area. Prior to the early 1970's, no records were kept of Louisiana pipeline installations. Since the passage of the Clean Water Act in 1973, COE has been mandated to issue permits for pipeline installations in wetlands. Although COE has these permits on file, the data are not compiled. The State of Louisiana has kept records on pipeline installations since 1980. Information obtained from the Louisiana Coastal Management Section Department of Natural Resources, indicates that coastal use permits were granted for 860 buried pipelines in the Louisiana coastal area between October 1980 and January 1983. According to MMS data, within the same period of the time, fewer than 20 pipelines from the OCS reached the coast of Louisiana. No comparable information is available for Texas.

Some indication of the total number of onshore pipeline installations is provided by well completion data. Approximately 41,190 wells have been completed in coastal Louisiana (USDI, GS, 1984). Of these, all successful gas wells required pipelines to transport production to trunklines. Oil production may be transported by pipelines, barges, or trucks. All three of these means of transportation, however, may result in wetland alterations (pipeline canals, navigation canals, or road construction). Although linear extent of the onshore pipeline networks has not been measured, the pattern is intricate and pervasive throughout the coastal area because of the dispersed distribution of the numerous oil and gas fields. Pipelines that originate on the OCS, however, gather production from widely distributed fields and bring it to shore through a small number of landfalls (3,056 offshore structures with 135 pipeline landfalls).

One factor which determines whether a pipeline right-of-way will erode into adjacent wetlands or revegetate is the presence or absence of exposed soil on which emergent vegetation can become established. Preliminary results of field studies by MMS on five pipelines in coastal Louisiana indicate that 20% of the corridor above the pipeline was vegetated. Natural control sites were 66% vegetated. Field observations during the study indicate that revegetation occurs faster and over a greater portion of the right-of-way where soils are firm. These observations, in view of the submergence rates being experienced in the Central Gulf, point to a long-term cumulative impact that will decrease the present rate and extent of revegetation of pipeline rights-of-way.

Miscellaneous factors, including marsh burning, marsh buggies, onshore oil and gas activities, well site construction and brine disposal, affect wetlands loss. Recent studies (Bahr and Wascom, 1984) report major marsh burns that resulted in permanent wetlands loss. Sikora et al. (1983) reported that in one 16 km^2 wetland area in coastal Louisiana, an alarming 18.5% of the area was covered with marsh buggy tracks. Well site construction activities involve board roads and ring levees. Ring levees are approximately 4-acre impoundments constructed around a well site. McGinnis et al. (1972) estimated that between 1950 and 1971, 20,442 well completions were made in coastal Louisiana. By 1984, the total number of wells drilled in the coastal parishes had increased to approximately 41,000, a 101% increase in 13 years (USDI, GS, 1984). Brine disposal associated with oil/gas exploration/production may have a significant local impact on wetlands near well sites.

Development of wetlands for agricultural, residential, and commercial uses is a major factor affecting wetlands loss in Louisiana. During the period 1952-1974 in the Chenier Plain region of southwestern Louisiana, an estimated

3,045 acres of wetlands was converted to urban use (Gosselink et al., 1979). During the period 1956-1978, an estimated 132,034 acres of urban/industrial development occurred in the Mississippi Deltaic Plain region of southern Louisiana (Bahr and Wascom, 1984). Coastal storms and hurricanes also cause severe soil erosion and loss of wetlands.

The probability of one or more oil spills occurring and contacting parishes/counties and environmental targets in the CPA, cumulatively, as a result of offshore oil/gas activities and tankering of imported crude oil are as follows: Cameron - 59%; Vermilion - 58%; Iberia - 44%; St. Mary - 5%; Terrebonne - 83%; Lafourche - 75%; Jefferson - 45%; Plaquemines - 89%; St. Bernard - 55%; Hancock, Harrison, Jackson - 20%; Mobile - 12%; and Louisiana marshes - 99%. Oil spills could also occur in coastal wetlands as a result of hydrocarbon activity in State waters. The extent of damage to wetlands from an oil spill depends on many factors (Section IV.B.). The majority of the oil spills which have occurred along the Gulf coast have not effected large areas of wetlands. Occasionally, small areas along the shoreline are contacted; however, an onshore oil pipeline break may affect larger areas (up to 100 acres) due to topography and drainage patterns. Oil spill contacts could cumulatively cause considerable destruction and severe alteration to coastal wetlands, resulting in a high level of impact.

Cumulatively, prior lease sales, the proposed action, and future lease sales are estimated to result in the following new onshore construction: 10 service bases requiring about 260 acres; 14 pipelines requiring about 3,360 acres; 1 pipeline installation base and pipeline coating yard in C-4 requring about 65 acres; 3 platform fabrication yards requiring about 1,200 acres; and 4 gas processing plants requiring about 240 acres (Table IVLH-C3). If all these onshore facilities are constructed, it could require a total of about 5,115 acres in the Central Gulf coastal region. It is not expected that all of this construction would occur in wetland areas; however, an undetermined amount of wetlands would probably be affected.

Conclusion

The cumulative level of impact to the coastal wetlands in the Central Gulf area from offshore oil/gas activities is estimated to be moderate; from other activities and natural occurrences, it is estimated to be very high.

(2) Impacts on Sensitive Offshore Habitats

The topographic features and "live bottom" areas of the Central Gulf are offshore habitats sensitive to offshore oil and gas activity. Separate analyses for these two habitats are given below.

The potential impact producing factors on the topographic features and live bottoms of the Central Gulf are oil spills, blowouts, anchoring, structure emplacement, and effluent discharge.

Oil spills may occur at the surface due to tanker spillage or at the seafloor due to pipeline rupture or well blowout. Surface spills could discharge large amounts of either crude or refined oil for a short period of time. Both surface and subsurface spills could result in a steady discharge of oil over a long period of time. These types of accidents are rare in the Gulf.

Blowouts can occur from either oil or gas wells. Oil well blowouts result in oil spills as discussed above. Both gas and oil well blowouts result in large amounts of bottom sediment being thrown into the water column. These sediments fall back to the seafloor and can affect the organisms living there. Blowouts are also relatively rare accidents.

Anchoring of pipeline lay barges, drilling rigs, or work boats and structure emplacement (pipeline, drilling rig, or platform emplacement) result in physical disturbance of the benthic environment. These activities are routine operations of oil and gas exploration and development and are unavoidable.

Drilling muds and cuttings discharges result in localized water turbidity, deposition on the surrounding seafloor, and potential effects of the low concentrations of toxic constituents. Drilling discharge is also a routine operation in exploration and production activity.

The potential impact producing factors are discussed more thoroughly in Section IV.A.4.

(a) Topographic Features

The following definitions are used to describe the expected levels of impact to the topographic features resulting from the proposed action:

Very High - A species, population, community, or assemblage will be harmed to the extent that recovery of that particular entity may not occur.

High - A significant interference with ecological relationships. This usually involves the mortality or a biological alteration of a noticeable segment of the population, community, or assemblage.

Moderate - A short-term interference with ecological relationships. Although some species may sustain substantial losses, other species will sustain low losses, and the ecological mix will not be altered.

Low - A few species may sustain low losses, but any interference with ecological relationships will not be evident.

Very Low - Loss of a few individuals but no interference with ecological relationships.

Of the topographic features listed in Table III-4, the following are located in the Central Gulf:

	Crest (m)	Surrounding Seafloor (m)	Category*	Shallowest Zone**
Shelf Edge Banks				
Bright Bank	37	110	A	*Stephanocoenia*
McGrail	45	120	A	*Stephanocoenia*
Rankin	52	125	A	Algal-Sponge
Alderdice	55	90	A	Algal-Sponge
Rezak	60	120	A	Algal-Sponge
Sidner	55	150	A	Algal-Sponge
Ewing	56	90	A	Algal-Sponge
Jakkula	59	130	A	Algal-Sponge
Bouma	60	95	A	Algal-Sponge
Parker	60	100	A	Algal-Sponge
Sackett	67	100	C	Algal-Sponge
Diaphus	73	120	C	Antipatharian
Sweet	75	175	N/A	Algal-Sponge
Midshelf Banks				
Sonnier	18	50	B	*Millepora*-Sponge
29 Fathom	52	72	N/A	Antipatharian
Fishnet	66	78	C	Antipatharian

* A - Maximum environmental protection is recommended.
B - Environmental protection is strongly recommended.
C - Environmental protection is recommended.
N/A - Bank is not categorized.
(Rezak and Bright, 1981).
**Biotic zones designated by Rezak and Bright, 1981 and Rezak et al., 1983 (Section III).

The topographic features of the Central Gulf are sensitive to oil and gas activities. For this reason, leases in past sales have contained a biological stipulation designed to protect these habitats from leasing activities. A stipulation is presented in Section II.A.1.c.(1) as a potential mitigative measure. An impact analysis is presented below for the proposed action and for the proposed action with the application of the biological lease stipulation.

Impact Analysis of the Proposed Action

The potential causes of adverse impacts on the topographic features resulting from oil and gas exploration and development are oil spills, blowouts, anchoring, structure emplacement, and drilling discharge as discussed above.

One large oil spill, two medium spills, and a number of small spills (mostly 1-5 bbls of oil) are assumed in the Central Gulf in this analysis. These oil spills may occur from either surface or seafloor sources. Surface spills could occur from tankers or oil platforms. Most of the small spills would occur from surface sources. The medium and large spills are equally likely to result from surface spills as seafloor spills. Oil from a surface spill can be driven into the water column. Measurable amounts have been documented at depths approximating 10 m. At this depth, the oil is only found at concentrations several orders of magnitude lower than the amount shown to have an effect on corals (Lange, 1985; McAuliffe et al., 1975 and 1981; Knap et al., 1985). In the Central Gulf, Sonnier Bank crests the shallowest at 18 m. Therefore, a surface oil spill would likely have no impact on the biota of Sonnier Bank or the other topographic features because any oil which might be driven to 18 m or deeper would be well below the concentrations needed to effect an impact.

If the one large and two medium spills were from seafloor sources, the impacts on topographic features could be different. A seafloor spill could occur from a pipeline rupture, a leak, or an oil well blowout. (The impacts from a blowout other than the release of oil into the water column are discussed under the impacts from blowouts below.) The biota of the topographic features of the Central Gulf could be significantly impacted by a seafloor oil spill. Oil spilled from a seafloor source may be entrained and transported for great distances in subsurface currents. This was the case for the Ixtoc-1 spill, where some oil released into the water column at the seafloor circulated in the Gulf below the surface for months before reaching the Texas coast (Section IV.B.6.b.). Such oil at depth could come in contact with the biologically sensitive topographic features (banks) of the Central Gulf. In addition, a subsurface spill over or very near one of the banks would have significant effects. Fifteen blocks in proximity to the topographic features can be expected to be leased as a result of the Central Gulf sale. From these leases, 35 exploratory wells and 3 platforms can be expected. Thus, the potential for a subsurface spill in proximity to the banks exists. The effluent could impinge directly upon the edge of the bank. Impacts could then be serious to the local biota. Destruction of the biota of such areas may have severe and long-lasting deleterious consequences on the specific commercial and recreational fisheries habitats affected, such as loss of habitat, loss of species (including prey species), destruction of hard substrate, and change in sediment characteristics, all of which may result in the reduction or loss of one or more fisheries. These areas also have intrinsic biological, ecological, and aesthetic values of their own which would be lost by such activities. Corals would probably not be impacted this severely. Knap et al. (1985) found that *Diploria strigosa* dosed with oil exhibited sublethal effects which occurred rapidly. The effects were short-term and recovery of the coral was rapid. *Diploria* appears to be relatively tolerant of brief exposures to chemically dispersed crude oil. Non-chemically dispersed oil adhered longer to the substrate and would lengthen the exposure time of coral to oil, thereby increasing the impacts. Of note is the fact that the cryptic fauna associated with the coral community may be more sensitive to oil dosage than the corals.

The probability of an oil spill occurring at all is low in the Central Gulf. The probability of the spill being from a seafloor source is even lower. Even if a seafloor oil spill were to occur, the spill would have to come into contact with a biologically sensitive feature. The fact that the topographic features are widely dispersed in the Central Gulf, combined with the probable random nature of spill locations would serve to limit the extent of damage from any given spill to only one of the sensitive areas. The current which moves around the banks may steer any spilled oil around the banks rather than directly upon the banks. Although the potential impact to the topographic features from an oil spill would be very high, the risk of such an event occurring is very low.

Blowouts can present a serious threat (due to burying by resuspended sediments) to important biological resources if one were to occur on or near a topographic feature (Section IV.C.1.). Gas well blowouts generally pose far less environmental risk than do oil spills, resulting only in very high concentrations of suspended sediments and increased levels of gas in the water column very near the source of the blowout. To the extent that oil or condensate is present in the reservoir, some liquid hydrocarbons may also be injected into the water column. The suspended sediments may be carried some distance by currents, but the bulk of the sediments are redeposited within a few thousand meters of the blowout site. Low-molecular-weight-hydrocarbons (gases) will dissolve in the water column until saturation is reached; both gaseous and dissolved low-molecular-weight-hydrocarbons will be released into the atmosphere within a few days of a blowout without major biological effect. Liquid hydrocarbons will be diluted to background levels within a few thousand meters distance from the blowout site and will degrade with time. Refer to Section IV.A.4. for a discussion of the impacts of documented blowouts in the Gulf of Mexico.

A blowout directly on a bank or nearby a bank would have serious long-term or permanent consequences. Thirty-five exploratory wells and 3 platforms can be expected near the banks of the Central Gulf. In most cases, it is expected that the currents will sweep the contaminants around the bank rather than deposit them on the bank (Rezak et al., 1983). Some small fraction of the sediments or oil may reach a bank and come in contact with organisms; the extent of damage will depend on the amount of contaminant and the length of time it remains on the bank. Amounts are not expected to be high because of dilution, dispersion, settling, and current action (sweeping the contaminant around the bank). Length of time on the bank may be long for the heavier sediments, but these are likely to settle out rapidly and not reach the bank at all (Brooks and Bernard, 1977). A large blowout occurring near a biologically sensitive area would have severe environmental consequences. Large amounts of the sediment resuspended by the blowout could smother the coral community causing mortality. Recolonization would be slow if at all. A blowout occurring directly on top of a bank would destroy not only the biota of the feature but also the feature itself making recolonization impossible. Such an accident would replace the topographic feature with a crater. Since the biota of the banks are dependent upon topographic relief, the community which was destroyed by the blowout could not recover.

Fortunately, blowouts are quite rare in the Gulf of Mexico. In addition to the low probability of occurrence, the blowout would have to be in close proximity to a topographic features to cause an impact. The risk to the biota of topographic features from blowouts is therefore low.

Considerable mechanical damage will be inflicted upon the bottom by normal and routine oil and gas operations. The drilling operation itself disturbs some small areas. The presence of the structure can cause scouring of the surficial sediments (Caillouet et al., 1981). Anchors from support boats and ships, floating drilling units, and pipeline laying vessels do a great deal of damage to the seafloor. The area actually affected will depend on depth of water, length of chain, size of anchor and chain, wind, and current. Anchoring at biologically sensitive areas would include crushing and breaking of coral heads. Anchoring often destroys a wide swath of sessile organisms when the anchor is dragged or the vessel swings at the anchor causing the anchor chain to drag the seafloor. Anchor damage from nonlease activity has been documented at the Flower Gardens (Section IV.A.4.).

Thirty-five exploratory wells and 3 platforms can be expected within 3 miles of the 16 sensitive banks in the Central Gulf. It is unlikely that any of these activities would occur directly on top of one of the 16 banks because of the hazards involved in drilling on an uneven seafloor such as at the banks and because hydrocarbons would not be expected directly under the banks but rather at the banks' flanks. However, it is likely that with so many activities occurring in proximity to the banks that anchoring of the rigs and of rig support boats would occur at the banks. MMS can, as part of the operational plan approval process for a specific lease activity (Section I), require conditions on the operator of a lease which could protect the banks from anchoring. Without a stipulation, these conditions are not required to be imposed. Therefore, impacts to the topographic features from the proposed action are assumed to be very high due to anchoring.

Pipeline emplacement also causes considerable disruption to the bottom (Section IV.C.4.). It is estimated that six acres of the bottom is physically disturbed per mile of pipeline laid; some 2,300-6,000 yd^3 of sediment are resuspended per mile of pipeline, depending on the size of the pipeline and depth of trenching (burial). Add to this damage caused by the eight anchors of the pipelaying barge and it is clear that considerable damage will be done if such activities are conducted in sensitive coral areas. Pipeline emplacement is not expected directly over the uneven topographic feature; however, in bypassing the feature the pipeline can be expected to be placed within deeper portions of the sensitive zones of a bank. MMS can impose restrictions as part of the development plan or pipeline application (Section I), but is not required to do so without the lease stipulation.

Thirty-five exploratory wells and 3 platforms can be expected within 3 miles of the 16 banks in the Central Gulf. These oil and gas operations will routinely discharge drilling muds and cuttings which may impact the biota of the banks due to toxic effects or turbidity and sedimentation. Most water-based fluids are nontoxic, and their effects are limited to the immediate vicinity of the discharge (NAS, 1983). The depth surrounding the topographic features ranges from 50-175 m. The water depth adds to the dilution of the drilling effluent. None of the wells or platforms are expected to be placed directly over the sensitive portions of the banks, as discussed above. Therefore, no effects to the biota of the topographic features are expected due to toxicity.

Impacts to the biota are expected, however, from the turbidity and sedimentation associated with drilling discharge. In the Gulf of Mexico OCS, about 90% of the discharge settles rapidly, usually within 1,000 m (NAS, 1983). Small amounts of drilling effluent may reach a bank from wells drilled more than 1,000 m away; however, these amounts from single wells, where measurable, would be extremely small and would have no effect on the biota. Continuous drilling of numerous wells in proximity to but greater than 1,000 m from a bank, as at a development platform, may cause an impact to the biota of a bank due to potential continuous exposure to low levels of effluent. The impact is not expected to be high from such an activity because it is unlikely with the varying currents that a bank would be subjected to effluent throughout the life of a drilling project and because the currents at the banks would keep the bank swept clean of fine sediments and would prevent the accumulation of drilling muds at the bank. Effluents discharged within 1,000 m of a bank would impact the biota of the bank. Drilling muds and cuttings discharge causes turbidity and sedimentation. The muds and cuttings can smother the sessile benthic invertebrates causing mortality. Turbidity from the discharge can cause reduced light levels to the benthic organisms and clogging of the feeding mechanisms of the sessile invertebrates. These conditions can lead to reduced productivity, susceptibility to infection, and mortality. MMS, as a condition of the operational plan approval, can require the operator of a lease to perform certain measures, such as shunting, which would reduce the impacts to the biota of the banks to very low. USEPA, through its NPDES permitting procedures, may also require mitigative measures.

Produced water discharge is sometimes cited as a potential hazard to the biota of topographic features. Produced water is relict seawater associated with produced hydrocarbons. It contains high concentrations of inorganic salts ranging from a few milligrams per liter to 350,000 mg/l. Hydrocarbons and organic compounds may be present in parts per million levels (Offshore Operators Committee, 1975).

The study of the Buccaneer oil field offshore (USDC, NMFS, 1977) reported that produced water was discharged at a rate of 138 m^3 per day between January 1975-February 1976. The average oil content of this produced water was 25.1 ppm. Near-platform macrobenthic populations were depressed and had a high turnover rate as compared to the surrounding sea bottom; this may have been a result of increased scour action around the platform structure itself, but no cause-effect relationship was established. OCS Order No. 7 requires that all discharges must meet USEPA standards which allow no more than 72 mg/1 daily maximum of oil and grease discharge and 48 mg/1 maximum monthly average (72 mg/1 is equivalent to 72 ppm). Due to the water depth at the topographic features, the discharged produced water would be greatly diluted. Therefore, the biota of topographic features are not expected to be affected by the discharge of produced waters.

Conclusion

Activities resulting from the proposed action will have a very high impact on the biota of the topographic features.

Impact Analysis of the Proposed Action with the Biological Stipulation

The proposed action with the topographic features stipulation would prohibit lessees from operating in an established "No Activity Zone" at each of the banks. The prohibition extends to all activity conducted by the lessee, including the anchoring of rigs and support vessels. In addition to the No Activity Zone, lessees in the vicinity of Diaphus and Fishnet Banks would be required to shunt all drilling muds and cuttings to within 10 m of the seafloor if the operations occurred within 1,000 m of the No Activity Zone. The stipulation would impose a shunt zone extending 1 mile and a shunt zone for development discharges extending 3 miles from the No Activity Zone for the remainder of the banks, excepting Sweet Bank.

The potential causes of adverse impacts on the topographic features resulting from oil and gas exploration and development are oil spills, blowouts, anchoring, structure emplacement, and drilling discharge as discussed above. The biological stipulation is designed to eliminate impacts to the topographic features from routine oil and gas activities.

One large oil spill, two medium spills, and a number of small spills (mostly 1-5 bbls of oil) are assumed in the Central Gulf in this analysis. These oil spills may occur from either surface or seafloor sources. Surface spills could occur from tankers or oil platforms. Most of the small spills would occur from surface sources. The medium and large spills are equally likely to result from surface spills as seafloor spills. Oil from a surface spill can be driven into the water column. Measurable amounts have been documented at depths approximating 10 m. At this depth, the oil is only found at concentrations several orders of magnitude lower than the amount shown to have an effect on corals (Lange, 1985; McAuliffe et al., 1975 and 1981; Knap et al., 1985). In the Central Gulf, Sonnier Bank crests the shallowest at 18 m. Therefore, a surface oil spill would likely have no impact on the biota of Sonnier Bank or the other topographic features because any oil which might be driven to 18 m or deeper would be well below the concentrations needed to effect an impact.

If the one large and two medium spills were from seafloor sources, the impacts on topographic features could be different. A seafloor spill could occur from a pipeline rupture, a leak, or an oil well blowout. (The impacts from a blowout other than the release of oil into the water column are discussed under the impacts from blowouts below.) The biota of the topographic features of the Central Gulf could be significantly impacted by a seafloor oil spill. Because of the lease stipulations, there would not be a seafloor spill directly over a topographic feature. However, oil spilled from a seafloor source may be entrained and transported for great distances in subsurface currents. This was the case for the Ixtoc-1 spill, where some oil released into the water column at the seafloor circulated in the Gulf below the surface for months before reaching the Texas coast (Section IV.B.6.b.). Such oil at depth could come in contact with the biologically sensitive topographic features (banks) of the Central Gulf. In addition, a subsurface spill very near one of the banks would have significant effects. Fifteen blocks in proximity to the topographic features can be expected to be leased as a result of the Central Gulf sale. From these leases, 35 exploratory wells and 3 platforms can be expected. Thus, the potential for a subsurface spill in proximity to the banks exists. The effluent could impinge directly upon the edge of the bank. Impacts could then be serious to the local biota. Destruction of the biota of such areas may have severe and long-lasting deleterious consequences on the specific commercial and recreational fisheries habitats affected, such as loss of habitat, loss of species (including prey species), destruction of hard substrate, and change in sediment characteristics, all of which may result in the reduction or loss of one or more fisheries. These areas also have intrinsic biological, ecological, and aesthetic values of their own which would be lost by such activities.

The probability of an oil spill occurring at all is low in the Central Gulf. The probability of the spill being from a seafloor source is even lower. Even if a seafloor oil spill were to occur, the spill would have to come into contact with a biologically sensitive feature. The fact that the topographic features are widely dispersed in the Central Gulf, combined with the probable random nature of spill locations would serve to limit the extent of damage from any given spill to only one of the sensitive areas. The current which moves around the banks may steer any spilled oil around the banks rather than directly upon the banks. Although the potential impact to the topographic features from an oil spill would be very high, the risk of such an event occurring is very low.

Blowouts can present a serious threat (due to burying by resuspended sediments) to important biological resources if one were to occur near a topographic feature (Section IV.C.1.). Gas well blowouts generally pose far less environmental risk than do oil spills, resulting only in very high concentrations of suspended sediments and increased levels of gas in the water column very near the source of the blowout. To the extent that oil or condensate is present in the reservoir, some liquid hydrocarbons may also be injected into the water column. The suspended sediments may be carried some distance by currents, but the bulk of the sediments are redeposited within a few thousand meters of the blowout site. Low-molecular-weight-hydrocarbons (gases) will dissolve in the water column until saturation is reached; both gaseous and dissolved low-molecular-weight-hydrocarbons will be released into the atmosphere within a few days of a blowout without major biological effect. Liquid hydrocarbons will be diluted to background levels within a few thousand meters distance from the blowout site and will degrade with time. Refer to Section IV.A.4. for a discussion of the impacts of documented blowouts in the Gulf of Mexico.

By establishing No Activity Zones, the stipulation will preclude blowouts directly on the banks. Nearby blowouts, however, may affect the bank if subsurface currents carry sediments or oil to the bank. Thirty-five exploratory wells and 3 platforms can be expected near the banks of the Central Gulf. In most cases, it is expected that the currents will sweep the contaminants around the bank rather than deposit them on the bank (Rezak et al., 1983). Some small fraction of the sediments or oil may reach a bank and come in contact with organisms; the extent of damage will depend on the amount of contaminant and the length of time it remains on the bank. Amounts are not expected to be high because of dilution, dispersion, settling, and current action (sweeping the contaminant around the bank). Length of time on the bank may be long for the heavier sediments, but these are likely to settle out rapidly and not reach the bank at all (Brooks and Bernard, 1977). A large blowout occurring near a biologically sensitive area would have severe environmental consequences. Large amounts of the sediment resuspended by the blowout could smother the coral community causing mortality. Recolonization would be slow if at all.

Fortunately, blowouts are quite rare in the Gulf of Mexico. In addition to the low probability of occurrence, the blowout would have to be in close proximity to a topographic features to cause an impact. The risk to the biota of topographic features from blowouts is therefore low.

Considerable mechanical damage will be inflicted upon the bottom by unrestricted routine oil and gas operations. The drilling operation itself disturbs some small areas. The presence of the structure can cause scouring of the surficial sediments (Caillouet et al., 1981). Anchors from support boats and ships, floating drilling units, and pipeline laying vessels do a great deal of damage to the seafloor. The area actually affected will depend on depth of water, length of chain, size of anchor and chain, wind, and current. Anchoring at biologically sensitive areas would include crushing and breaking of coral heads. Anchoring often destroys a wide swath of sessile organisms when the anchor is dragged or the vessel swings at the anchor causing the anchor chain to drag the seafloor. Anchor damage from nonlease activity has been documented at the Flower Gardens (Section IV.A.4.).

Pipeline emplacement also causes considerable disruption to the bottom (Section IV.A.4.). It is estimated that six acres of the bottom is physically disturbed per mile of pipeline laid; some 2,300-6,000 yd^3 of sediment are resuspended per mile of pipeline, depending on the size of the pipeline and depth of trenching (burial). Add to this damage caused by the eight anchors of the pipelaying barge and it is clear that considerable damage will be done if such activities are conducted in sensitive coral areas.

A biological stipulation is being offered for consideration by the Secretary. The stipulation would impose a No Activity Zone on sensitive coral areas. Within this zone, no drilling or platform, rig, pipeline, or anchor emplacement would be allowed. Therefore, damage to these sensitive biological areas from oil and gas operations would be prevented.

Routine oil and gas operations discharge drilling muds and cuttings. Drilling discharges will cause turbidity and smothering of the benthos in proximity to the drill site. Thirty-five exploratory wells and 3 platforms can be expected within 3 miles of the 16 sensitive banks in the Central Gulf. In the Gulf of Mexico OCS, about 90% of the discharge settles rapidly, usually within 1,000 m. Impacts to the biota may also result from the toxic components of the drilling muds. Most water-based fluids are nontoxic, and their effects are limited to the immediate vicinity of the discharge (NAS, 1983). Therefore, no significant effects to the biota of the topographic features are expected from drilling muds and cuttings discharges greater than 1,000 m from the feature.

At distances less than 1,000 m, and at some banks less than 1 nmi, all muds and cuttings discharges would be restricted by the stipulation. The stipulation would require that muds and cuttings discharge be shunted to within 10 m of the seafloor. Shunting of the effluent into the nepheloid layer of water confines the effluent to depths greater than the depths at which the sensitive biota exist (NAS, 1983). Even with worst case oceanographic conditions, the water from the base of a bank (containing also the shunted effluent) cannot flow from the base to the level of the living reef (Rezak and Bright, 1981). Thus, no effect on the biota of the topographic features is expected from discharges within 1,000 m of where they are shunted to the seafloor.

The topographic features which are categorized as Category A or B banks (Rezak and Bright, 1981) and the uncategorized 29 Fathom Bank (see table above) are protected by additional restrictions imposed by the stipulation. These banks would require that effluent discharged within 1 nmi of the bank be shunted to the seafloor and development effluent discharged within 3 nmi be shunted. Although, as discussed above, most of the effects from drilling muds and cuttings are limited to within 1,000 m of the (surface) discharge, the additional preclusion of surface discharge out to 1 nmi and out to 3 nmi for development is included for these banks because of their higher resource category and sensitivity. Small amounts of drilling discharge may reach the banks from unshunted wells drilled more than 1 nmi away; however, these amounts where measurable are extremely small and had no effect on the biota. Where drilling of many wells may take place near the same bank during the same time interval, as in development drilling, continued exposure to low levels of effluent may induce an effect on the biota. Due to the extremely low levels expected any effect is not expected to be significant. However, because impacts from such activity have not been studied, the stipulation will require the lessee to shunt discharges from development operations within 3 mi of the high category banks. On a case-by-case basis the MMS may impose shunting of exploratory wells in the 3 Mile Zone in the unlikely event that numerous exploratory wells are planned during the same time interval at the same bank. Therefore, no impacts are expected from the discharge of drilling effluents.

Produced water discharge is sometimes cited as a potential hazard to the biota of topographic features. Produced water is relict seawater associated with produced hydrocarbons. It contains high concentrations of inorganic salts ranging from a few milligrams per liter to 350,000 mg/l. Hydrocarbons and organic compounds may be present in parts per million levels (Offshore Operators Committee, 1975).

The study of the Buccaneer oil field offshore (USDC, NMFS, 1977) reported that produced water was discharged at a rate of 138 m^3 per day between January 1975-February 1976. The average oil content of this produced water was 25.1 ppm. Near-platform macrobenthic populations were depressed and had a high turnover rate as compared to the surrounding sea bottom; this may have been a result of increased scour action around the platform structure itself, but no cause-effect relationship was established. OCS Order No. 7 requires that all discharges must meet USEPA standards which allow no more than 72 mg/1 daily maximum of oil and grease discharge and 48 mg/1 maximum monthly average (72 mg/1 is equivalent to 72 ppm). Produced water discharges near topographic features will have to be shunted to near the bottom as required by the biological stipulation. Therefore, the biota of topographic features are not expected to be affected by the discharge of produced waters.

Conclusion

Activities resulting from the proposed action with the biological stipulation will have a very low impact on the biota of the topographic features.

Cumulative Impacts of the Proposed Action

Existing oil and gas lease operations, tankering, commercial and recreational activities, and natural events are potential impact producing factors which, along with the proposed action, may cumulatively impact the biota of the topographic features of the Central Gulf.

Oil and gas leasing has been increasing around the topographic features of the Central Gulf, and this trend is expected to continue in the future. Of the 177 blocks in the CPA which are within proximity to the topographic features, 110 are under active lease (Appendix A). Recent leasing near the banks has resulted not only from interest in "virgin" blocks but also from the releasing of expired or relinquished lease blocks (Figure IV-4). Cumulatively, a total of 310 exploratory wells and 20 platforms can be expected to have been drilled near the topographic features as a result of past lease sales and the proposed action. Many oil and gas operations on the previously leased blocks are subject to the provisions of a biological stipulation. These operations are not expected to have an adverse impact on the biota of the topographic features. Thus, the impact from cumulative oil and gas routine operations would be limited to the impacts from the operations conducted as a result of the proposed action. These impacts as discussed above are to be very high, if performed in an unregulated and unrestricted manner.

Increased leasing near topographic features increases the probability that a blowout or seafloor oil spill may occur in proximity to a feature. Such an occurrence could be catastrophic as discussed above. However, even with the increased probability of occurrence, blowouts and seafloor oil spills are extremely rare in the Gulf, and the probability that the spill or suspended sediments would reach a bank is even less.

Anchor damage is considered to be the most serious threat to coral and coral-community areas (Bright and Rezak, 1978 and Rezak and Bright, 1981). The biological stipulation on the existing leases prohibits the anchoring of industry-related vessels in the No Activity Zones; the stipulation does not affect other activities such as tankering, fishing, or recreational SCUBA diving nor wouuld it prohibit industry-related anchoring on leases as a result of the proposed action. No data are available on the extent to which such anchoring may take place; however, all three activities are known to occur in proximity to the topographic features.

Nearly all the banks are near the established shipping fairways. The banks are apparently well-known fishing areas. Several of the shallower cresting banks are SCUBA trip destinations. Anchoring at a topographic feature by a vessel involved in any of these activities would cause significant damage to the biota, although the degree of damage would depend on the size of the anchor and chain. Damage to the East Flower Garden Bank from a tug was documented by CSA (1984) (Section IV.A.). Anchoring at the banks may diminish as the shipping industry becomes aware of the damage their anchors do to the biota of the banks. The Coral FMP (Section I.B.4.b.) also provides regulations for protection to coral from anchoring. However, the application of these regulations to nonfishing activities is uncertain. Therefore, there is potential for serious anchor damage to the biota of topographic features despite the regulations in place and proposed.

Treasure hunters have destroyed large areas of Bright Bank by using explosives to blast through the coral reef. The impact has been high to Bright Bank as a result of this blasting activity.

Impacts to the topographic features could occur as a result of operational discharges from tankers. Due to the dilution factor and the depths of the banks, this activity is not expected to have a high level of impact on the topographic features.

Impacts from natural occurrences such as hurricanes are not expected to result to the banks. An industry-funded monitoring effort was underway at the Flower Garden Banks during the passage of Hurricane Alicia directly over the banks. The results of this study showed no effect on the biota of the bank due to Alicia.

Conclusion

The cumulative impact to the topographic features of the Central Gulf is expected to be very high.

BLOCKS LEASED IN PROXIMITY TO TOPOGRAPHIC FEATURES CENTRAL GULF OF MEXICO

(BASED ON 198 TOTAL BLOCKS)

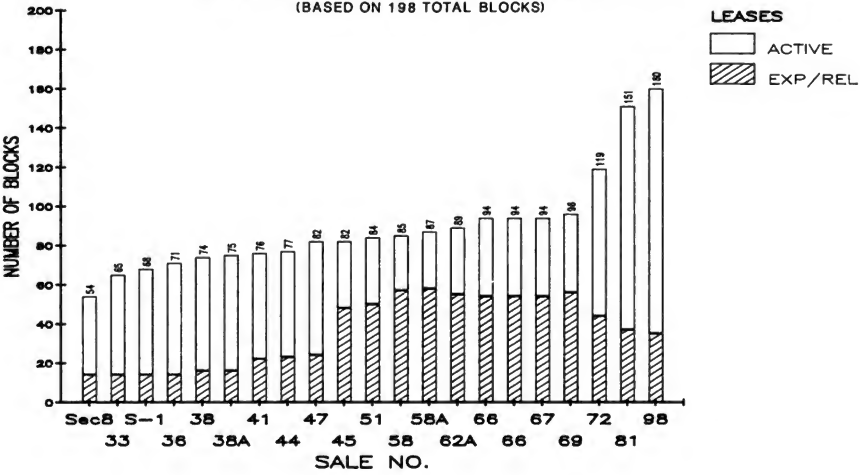


Figure IV-4

(b) Live Bottoms

The following definitions are used to describe the expected level of impact to the live bottom areas resulting from the proposed action:

Very High	- Substantial and permanent destruction of a large portion of the pinnacle environment and the assemblage thereon.
High	- Mortality of the pinnacle community and destruction of the environment such that recovery is long-term (greater than one year).
Moderate	- Substantial damage to a localized area. Recovery may be precluded or long-term.
Low	- Short-term interference with ecological relationships. Recovery is short-term (less than one year).
Very Low	- Localized short-term interference with ecological relationships.

The live bottoms of concern in the Central Gulf are associated with the pinnacle trend area. The pinnacle trend is located between 240-330 feet water depth in the Main Pass and Viosca Knoll lease areas. The pinnacles are scattered in this band. Live bottom areas are sensitive to oil and gas activities. For this reason leases in past sales have contained a live bottom stipulation. A stipulation is presented in Section II.A.1.c.(2) as a potential mitigative measure. An impact analysis is presented below for the proposed action and for the proposed action with the application of the biological lease stipulation.

Impact Analysis of the Proposed Action

The potential causes of adverse impacts to the pinnacle trend resulting from oil and gas exploration and development are oil spills, blowouts, anchoring, structure emplacement, and drilling discharge as discussed above.

One large oil spill, two medium spills, and a number of small spills (mostly 1-5 bbls of oil) are assumed in the Central Gulf in this analysis. These oil spills may occur from either surface or seafloor sources. Surface spills could occur from tankers or oil platforms. Most of the small spills would occur from surface sources. The medium and large spills are equally likely to result from surface spills as seafloor spills. Oil from a surface spill can be driven into the water column. Measurable amounts have been documented at depths approximating 10 m driven into the water column. At this depth, the oil is only found at concentrations several orders of magnitude lower than the amount shown to have an effect on marine organisms (Lange, 1985; McAuliffe et al., 1975 and 1981). Surface oils spills would likely have no impact on the biota of the pinnacle trend since the crests of these features are deeper than 10 m.

If the one large and two medium spills were from seafloor sources, the impacts on the pinnacles could be different. A seafloor spill could occur from a pipeline rupture, a leak, or an oil well blowout. (The impacts from a blowout other than the release of oil into the water column are discussed under the impacts from blowouts below.) The biota of the pinnacles of the Central Gulf could be significantly impacted by a seafloor oil spill. The effluent could impinge directly upon the edge of the pinnacles. Impacts could then be serious to the local biota. However, these biota would recover once the pinnacles were clear of the oil.

The probability of an oil spill occurring at all is low in the Central Gulf. The probability of the spill being from a seafloor source is even lower. Even if a seafloor spill were to occur, the spill would have to come into contact with a pinnacle feature. These factors would serve to limit the extent of damage from any given spill.

Blowouts can pose a threat to the biota of the pinnacles if one were to occur near one of these pinnacles. Gas well blowouts generally pose far less environmental risk than do oil spills, resulting only in very high concentrations of suspended sediments and increased levels of gas in the water column very near the source of the blowout. To the extent that oil or condensate is present in the reservoir, some liquid hydrocarbons may also be injected into the water column. The suspended sediments may be carried some distance by currents, but the bulk of the sediments are redeposited within a few thousand meters of the blowout site. Low-molecular-weight-hydrocarbons (gases) will dissolve in the water column until saturation is reached; both gaseous and dissolved low-molecular-weight-hydrocarbons will be released into the atmosphere within a few days of the blowout without major biological effect. Liquid hydrocarbons will be diluted to background levels within a few thousand meters distance from the blowout site and will degrade with time. A blowout could result in the smothering of the biota of a pinnacle due to sedimentation. These biota are adapted to life in turbid conditions and heavy sedimentation. Therefore, should mortality occur, recovery would be rapid.

Considerable mechanical damage will be inflicted upon the bottom by unrestricted routine oil and gas operations. The drilling operation itself disturbs some small areas. Of the 58 blocks in the pinnacle trend area, only 25 are available for lease. Ten can be expected to be leased as a result of the proposed activity. An estimated 25 exploratory wells and 2 platforms are expected in the pinnacle trend as a result of the proposed action.

Anchors from support boats and ships, floating drilling units, and pipeline laying vessels do a great deal of damage to the seafloor. The area actually affected will depend on depth of water, length of chain, size of anchor and chain, wind, and current. Anchor damage is the most serious threat to live bottom areas. Anchor damage would include crushing and breaking of pinnacles. Anchoring often destroys a wide swath of habitat when the anchor is dragged or the vessel swings at anchor causing the anchor chain to drag the seafloor.

Pipeline emplacement also causes considerable disruption to the bottom (Section IV.A.4.). It is estimated that six acres of the bottom is physically disturbed per mile of pipeline laid; some 2,300-6,000 yd^3 of sediment are resuspended per mile of pipeline, depending on the size of the pipeline and depth of trenching (burial). Add to this damage caused by the eight anchors of the pipelaying barge and it is clear that considerable damage will be done if such activities are conducted in the pinnacle trend area.

Mechanical damage of an area of the pinnacle trend is likely to be permanent. The structural relief offered by the pinnacles would be severely reduced by mechanical damage.

Routine oil and gas operations discharge drilling muds and cuttings. Drilling discharges will cause turbidity and smothering of the benthos in proximity to the drill site. In the Gulf of Mexico OCS, about 90% of the discharge settles rapidly, usually within 1,000 m. Impacts to the biota may also result from the toxic components of the drilling muds. Most water-based fluids are nontoxic and their effects limited to the immediate vicinity of the discharge (NAS, 1983).

Deposition of drilling muds and cuttings on the pinnacle trend area would not significantly impact the biota of the pinnacles or the habitat itself. The biota are adapted to life in turbid conditions and to high sedimentation. The depth of water would dilute the effluent to a significant degree. The pinnacles themselves are coated with a veneer of sediment. Any additional deposition and turbidity caused by a nearby well is not expected to significantly affect the pinnacle environment.

Conclusion

Activities resulting from the proposed action are expected to have a high level of impact on the pinnacle trend environment.

Impact Analysis of the Proposed Action with the Biological Stipulation

The live bottom stipulation would require lessees within specified blocks in Main Pass and Viosca Knoll Areas to conduct a live bottom survey using geophysical equipment in order to determine the presence of pinnacles. Upon location of pinnacles, the Regional Director (RD) could then require appropriate measures to ensure protection of the resource, for example: site relocation, anchoring restrictions, or monitoring to assess the extent of damage to a pinnacle area.

The potential causes of adverse impacts to the pinnacle trend resulting from oil and gas exploration and development are oil spills, blowouts, anchoring, structure emplacement, and drilling discharge as discussed above. The biological stipulation is designed to identify the pinnacles so that appropriate measures may be taken to minimize impacts to the pinnacle trend from routine oil and gas activities.

One large oil spill, two medium spills, and a number of small spills (mostly 1-5 bbls of oil) are assumed in the Central Gulf in this analysis. These oil spills may occur from either surface or seafloor sources. Surface spills could occur from tankers or oil platforms. Most of the small spills would occur from surface sources. The medium and large spills are equally likely to result from surface spills as seafloor spills. Oil from a surface spill can be driven into the water column. Measurable amounts have been documented at depths approximating 10 m driven into the water column. At this depth, the oil is only found at concentrations several orders of magnitude lower than the amount shown to have an effect on marine organisms (Lange, 1985; McAuliffe et al., 1975 and 1981). Surface oils spills would likely have no impact on the biota of the pinnacle trend since the crests of these features are deeper than 10 m.

If the one large and two medium spills were from seafloor sources, the impacts on the pinnacles could be different. A seafloor spill could occur from a pipeline rupture, a leak, or an oil well blowout. (The impacts from a blowout other than the release of oil into the water column are discussed under the impacts from blowouts below.) The biota of the pinnacles of the Central Gulf could be significantly impacted by a seafloor oil spill. The effluent could impinge directly upon the edge of the pinnacle. Impacts could then be serious to the local biota. However, these biota would recover once the pinnacles were clear of the oil.

The probability of an oil spill occurring at all is low in the Central Gulf. The probability of the spill being from a seafloor source is even lower. Even if a seafloor spill were to occur, the spill would have to come into contact with a pinnacle feature. These factors would serve to limit the extent of damage from any given spill. The current which moves around the banks may steer any spilled oil around the banks rather than directly upon the banks.

Blowouts can pose a threat to the biota of the pinnacles if one were to occur near one of these pinnacles. Gas well blowouts generally pose far less environmental risk than do oil spills, resulting only in very high concentrations of suspended sediments and increased levels of gas in the water column very near the source of the blowout. To the extent that oil or condensate is present in the reservoir, some liquid hydrocarbons may also be injected into the water column. The suspended sediments may be carried some distance by currents, but the bulk of the sediments are redeposited within a few thousand meters of the blowout site. Low-molecular-weight-hydrocarbons (gases) will dissolve in the water column until saturation is reached; both gaseous and dissolved low-molecular-weight-hydrocarbons will be released into the atmosphere within a few days of the blowout without major biological effect. Liquid hydrocarbons will be diluted to background levels within a few thousand meters distance from the blowout site and will degrade with time. A blowout could result in the smothering of the biota of a pinnacle due to sedimentation. These biota are adapted to life in turbid conditions and heavy sedimentation. Therefore, should mortality occur, recovery would be rapid.

Considerable mechanical damage will be inflicted upon the bottom by unrestricted routine oil and gas operations. The drilling operation itself disturbs some small areas. The presence of the structure can cause scouring of the surficial sediments (Caillouet et al., 1981). Of the 58 blocks in the pinnacle trend area, only 25 are available for lease. Ten can be expected to be leased as a result of the proposed activity. An estimated 25 exploratory wells and 2 platforms are expected in the pinnacle trend as a result of the proposed action.

Anchors from support boats and ships, floating drilling units, and pipeline laying vessels do a great deal of damage to the seafloor. The area actually affected will depend on depth of water, length of chain, size of anchor and chain, wind, and current. Anchor damage is the most serious threat to live bottom areas. Anchor damage would include crushing and breaking of pinnacles. Anchoring often destroys a wide swath of habitat when the anchor is dragged or the vessel swings at anchor causing the anchor chain to drag the seafloor.

Pipeline emplacement also causes considerable disruption to the bottom (Section IV.A.4.). It is estimated that six acres of the bottom is physically disturbed per mile of pipeline laid; some 2,300-6,000 yd^3 of sediment are resuspended per mile of pipeline, depending on the size of the pipeline and depth of trenching (burial). Add to this damage caused by the eight anchors of the pipelaying barge and it is clear that considerable damage will be done if such activities are conducted in the pinnacle trend area.

Mechanical damage of an area of the pinnacle trend is likely to be permanent. The structural relief offered by the pinnacles would be severely reduced by mechanical damage. The proposed action includes a biological stipulation which would impose survey requirements to precisely locate any pinnacles within a lease. Well specific measures could then be required to protect the pinnacle environment.

Routine oil and gas operations discharge drilling muds and cuttings. Drilling discharges will cause turbidity and smothering of the benthos in proximity to the drill site. In the Gulf of Mexico OCS, about 90% of the discharge settles rapidly, usually within 1,000 m. Impacts to the biota may also result from the toxic components of the drilling muds. Most water-based fluids are nontoxic and their effects limited to the immediate vicinity of the discharge (NAS, 1983).

Deposition of drilling muds and cuttings on the pinnacle trend area would not significantly impact the biota of the pinnacles at the habitat itself. The biota are adapted to life in turbid conditions and to high sedimentation. The depth of water would dilute the effluent to a significant degree. The pinnacles themselves are coated with a veneer of sediment. Any additional deposition and turbidity caused by a nearby well is not expected to significantly affect the pinnacle environment.

Conclusion

Activities resulting from the proposed action with the biological stipulation are expected to have a very low level of impact on the pinnacle trend environment.

Cumulative Impacts of the Proposed Action

Existing oil and gas lease operations, tankering, and commercial and recreational activities are potential impact producing factors which, along with the proposed action, may cumulatively impact the pinnacle trend environment of the Central Gulf.

Of the 58 blocks in the pinnacle trend area, 33 are under active lease. Cumulatively, a total of 50 exploratory wells and 5 platforms can be expected to have been drilled near the live bottoms of the Central Gulf as a result of past lease sales and the proposed action.

Mechanical damage due to anchoring is expected to be the most serious threat to the pinnacle trend environment. The area of the pinnacle trend is located near a shipping fairway. Ships using this fairway into Mobile, Alabama, can be expected to anchor in this area on occasion. Fishermen may anchor here as they fish. This anchoring can cause severe and permanent damage to the pinnacles.

Impacts to the pinnacle trend could occur as a result of discharge of operational discharges. Due to the dilution factor and the depths of the pinnacles, this activity is not expected to have a high level of impact on the pinnacles.

Conclusion

The cumulative impact to the pinnacle trend environment of the Central Gulf is expected to be high, primarily due to non-OCS-related activities.

(3) Impacts on Water Quality

The following five impact levels will be used in the following analysis of potential impacts on both offshore and onshore water quality.

Very High - Water quality parameters change significantly by several orders of magnitude; toxic trace metals or hydrocarbons exceed USEPA safe levels; changes persist for months or longer.

High - Water quality parameters change significantly by one or two orders of magnitude; toxic trace metals or hydrocarbons near USEPA safe levels; changes persist for days to weeks.

Moderate - Statistically significant changes in water quality parameters which persist for several weeks.

Low - Some measures of water quality deviate significantly from ambient measures but are quickly (within 1-2 days) restored to normal.

Very Low - Normal measures of water quality such as oxygen content, salinity, temperature, transmittance, trace metal concentrations, and hydrocarbon levels show no statistically significant changes from ambient conditions (Table III-2).

(a) Offshore

Under normal offshore operations, varying degrees of water quality degradation will occur as a result of oil and gas exploration and development activities in the Gulf of Mexico. Wastes from these activities are varied and may be transformed chemically, biologically, or radioactively when introduced into the marine environment. These wastes may be dissolved and form new substances or be mixed vertically and horizontally in the water column by small-scale motions or large-scale currents, and they may fall into the bottom sediments or be recycled by these same processes. This series of transformations or chemical reactions will govern a waste's transport through the water column and its toxicity to marine organisms. The bio-effects may be on individual organisms or whole ecosystems, with long-term effects such as changes in reproductive habits or genetic make-up of species. The method of delivery to the environment as well as the intrinsic chemical properties of each source will influence a waste's distribution throughout the Gulf.

Due to the complexity of these waste movements and behaviors, several parameters are needed to determine their extent of impact. Specification of point source functions, the form of the waste, rate of release, frequency of disposal, and geographical location of disposal are parameters essential in determining the extent of impact on water quality in any given area (Workshop . . . 1979). Also important are the areas impacted, the duration of impact, and the period of recovery. Potential water quality degradation resulting from increased offshore OCS oil and gas operations will be governed by several factors which include the resuspension of bottom sediments through exploration and development activities and pipeline construction; the discharge of deck drainage, sanitary wastes, and domestic wastes; the discharge of formation waters or produced waters; the discharge of drilling fluids and muds; accidental hydrocarbon discharges due to spills, blowouts, etc.; and the discharge of radionuclides into the marine environment. These factors are more thorougly discussed in Section IV.A.4.

Impact Analysis

In the Central Gulf, the addition of some 320 exploration/delineation wells, 408 development/production wells, 34 platforms, and up to 200 miles of pipelines are estimated for this area. Under this scenario, the discharge of an estimated 2.6-234.0 million bbls of formation waters, 3.3 million bbls of drilling muds, 0.37 million yds3 of drill cuttings, 130,000 bbls of sand from drilling operations, and an average of 142,800 gallons per day of treated sanitary domestic wastes from platforms may be expected as a result of the proposed action (Table IV-27). Pipeline-related activities would result in the disturbance of up to 1.2 million yds^3 of sediment under the same scenario. Contaminants from marine transportation activities may enter the Gulf as a result of routine operational discharges or as a result of accidental spills. Activities consisting of supply boat and shuttle tankering trafficking in support of the proposed action would routinely discharge pollutants consisting of domestic waste products such as sewage, food waste, and trash or debris. Of primary concern would be problems related to the movement of crude oil and offshore loading practices, where the potential exists for accidental spills to occur. One oil spill greater than or equal to 1,000 bbls is assumed for the Central Gulf, based on the Oil Spill Risk Analysis (Section IV.B.2). Petroleum hydrocarbons introduced into the marine and coastal waters as a result of this spill may have varied effects on the local biota with impacts ranging from negligible to very high, depending on the resource impacted, the stage of weathering, and the local physical and meteorological parameters. Normal weathering processes, encountered with oil spilled into open water conditions, tend to detoxify the spilled oil by breaking down the toxic components of the oil. (See Section IV.B.6. for a discussion of fates and effects of spilled oil.)

Immediate effects would be brought on by increased drilling, construction, and pipelaying activities, causing an increase in water column turbidities of the affected waters. Such increases would have a nominal impact on the productivity of phytoplankton, but may cause a temporary clog in the respiratory and feeding mechanisms of numerous benthic and pelagic marine organisms within the area of construction. Pipeline construction activities may also result in the resuspension of some 1.2 million yd^3 of sediment and settled pollutants, toxic heavy metals, and pesticides if present.

The discharge of an average of 142,800 gallons per day of treated sanitary wastes from rigs and platforms will increase levels of suspended solids, nutrients, chlorine, and BOD in a small area near the point of discharge. However, as a result of treatment prior to discharge as is required through USEPA's NPDES discharge permitting program, when combined with seawater these constituents are quickly diluted.

During the course of exploration drilling and workover phases resulting from the proposed action, the discharge of drilling fluids, cuttings, and sand will degrade the quality of the waters surrounding the proposed new platforms.

Table IV-27

M Scenario Estimates of Effluent Discharges Due to Increased OCS Activities as a Result of Central Gulf Sale 110

		Exploration and Delineation Derived		Production Derived			
Year	Produced Waters (million bbls)	Drill Cuttings (yd^3)	Drilling Muds (bbls)	Drill Cuttings (yd^3)	Drilling Muds (bbls)	Platform Derived Domestic and Sanitary Wastes (gal/day)	Sediment Disturbed by Pipelaying Activities (yd^3)
1986	-	-	-	-	-	-	-
1987	-	-	-	-	-	-	-
1988	-	5,110	45,500	-	-	-	-
1989	0.005 - 0.45	10,220	91,000	5,110	45,500	2,900 - 5,500	6,900 - 18,000
1990	0.008 - 0.72	17,885	159,250	10,200	91,000	8,700 - 16,500	13,800 - 36,000
1991	0.026 - 2.34	38,325*	341,250*	20,400	182,000	17,400 - 33,000	20,700 - 54,000
1992	0.130 - 11.70	35,770	318,500	30,660	273,000	29,000 - 55,000	27,600 - 72,000
1993	0.156 - 14.04	20,440	182,000	30,660*	273,000*	43,500 - 82,500	147,200 - 384,000*
1994	0.182 - 16.38	12,775	113,750	30,660	273,000	58,000 - 110,000	34,500 - 90,000
1995	0.234 - 21.06	10,220	91,000	20,440	182,000	72,500 - 137,500	34,500 - 90,000
1996	0.234 - 21.06	5,621	50,000	15,330	136,500	84,100 - 159,500	27,600 - 72,000
1997	0.234 - 21.06	5,621	50,050	14,308	127,400	89,900 - 170,500	13,800 - 36,000
1998	0.221 - 19.89	1,533	13,650	10,220	91,000	95,700 - 181,500	126,500 - 330,000*
1999	0.195 - 17.55	-	-	10,200	91,000	98,600 - 187,000	6,900 - 18,000
2000	0.187 - 16.83	-	-	10,200	91,000	***	-
2001	0.177 - 15.93	-	-	-	-	***	-
2002	0.156 - 14.04	-	-	-	-	***	-
2003	0.130 - 11.70	-	-	-	-	***	-
2004	0.091 - 8.19	-	-	-	-	***	-
2005	0.065 - 5.85	-	-	-	-	***	-
2006	0.057 - 5.13	-	-	-	-	***	-
2007	0.047 - 4.23	-	-	-	-	***	-
2008	0.031 - 2.79	-	-	-	-	***	-
2009	0.021 - 1.89	-	-	-	-	***	-
2010	0.013 - 1.17	-	-	-	-	***	-
Totals	2.6 - 234	163,520	1.45 M**	208,488	1.85 M**	98,600 - 187,000*	0.46 - 1.2 M**

*Denotes peak year

**Denotes million

***Quantities will vary depending upon platform occupancy, etc.

Drilling fluid/cutting discharges will be continuous or bulk. Some 3.3 million bbls of drilling muds and 0.37 million yd^3 of drill cuttings are estimated to result from drilling activities associated with the proposed action. Continuous discharges may come from the solids control equipment on each platform, while bulk discharges (commonly known as active mud discharges or mud tank dumps) are discharges of large volumes of fluids and cuttings (16-190 m3), at rates of discharge (80-110 m^3/h) and lasting for a period of 20 minutes to 3 hours (Mors et al., 1982; Petrazzuolo, 1981). Concern has been expressed regarding the effects of drilling muds and cutting discharges on the marine environment. Based on the findings of NAS (1983), Symposium (1980), Neff (1981), Petrazzuolo (1981), Menzie (1982), and others, their results suggest that the environmental risk of exploratory drilling discharges to most OCS marine communities are small. More than 96% of the whole drilling fluids tested in short-term experiments are classified as "slightly toxic" or practically "nontoxic." Toxicity does not seem to be a problem at the concentrations of material found at distances greater than 200-500 m from the discharge point, and not at distances greater than 1,000 m. Much of the toxicity of the mud aqueous faction of drilling fluids appears to be attributable to volatile organic components, which may include petroleum hydrocarbons and by-products of lignosulfonate and lignite, whereas suspended solids may cause mortality in sensitive species and juveniles by clogging and damaging gill epithelia. Benthic infauna tend to be affected to the greatest extent by offshore drilling waste disposal, but most of the studies suggest that impacts are restricted to an area within 300-500 m of the discharge site. Although dilution is extremely rapid in offshore waters to the extent that every substance measured in the water column, including turbidity, is at background by a distance of 1,000-2,000 m, uncertainties regarding effects still exist for low energy depositional environments which experience large inputs of drilling discharges over long periods of time. For a more detailed discussion of drilling fluid/cutting discharges on the marine environment, see Section IV.A.4.

Produced water is by far the largest quantity of waste to be discharged during normal oil and gas operations resulting from the proposed action. Up to 234 million bbls of these waters are estimated to result from the proposed action. The majority of these waters will be discharged directly to the surface waters surrounding the individual platforms; however, in more sensitive areas and in some instances they may be piped ashore and treated for further disposal below ground, on land, or into coastal waters. The effects of produced waters on marine flora and fauna have been examined in laboratory bioassays and several case studies of existing production fields. Concern has been expressed regarding the individual synergistic and antagonistic effects of the various constituents of these waters, but the separation of components effects has not been possible in either case studies or bioassays. In production field case studies, the discharges of other wastes such as drilling fluids and deck drainage has complicated delineation of the source of trace metals and hydrocarbons while there have been no laboratory studies which identify the cause of produced water toxicity. Regional variations in the content of the produced water, as well as temporal changes in its composition during the life of a given well, have also complicated investigations on the effects of this production waste. The published literature indicates that produced waters and brine are only slightly toxic (1%-10%) to practically nontoxic to most marine organisms, using those standards commonly cited for describing acute toxicity (Rose, 1981). The limited toxicity data available for juvenile and larval stages of shrimp and fish suggest, however, that immature individuals may be more sensitive than adults to the effects of produced waters. The sublethal effects of produced waters have also been examined during laboratory and field investigations and generally suggest that detrimental effects would not occur at concentrations of produced waters which could be reasonably expected near the offshore discharge rates (Arctic Laboratories Limited et al., 1983).

In contrast to the lack of laboratory bioassay data, the effects of produced water have been examined in several case studies of offshore production areas; the most detailed of these have been completed in the Gulf of Mexico. Of those conducted within the Gulf, the only significant affects on biota to be documented occurred when produced waters were discharged into shallow bays and estuaries. Mackin (1973) reported that produced water discharges totally destroyed the benthic community within 15 m of the discharges in a shallow (2.4 m) Texas estuary. Some mortality was observed at a distance of 91 m; however, a zone of increased productivity was found from 122 m to several thousand meters from the discharge. Based on studies conducted in Trinity Bay, Texas (Armstrong et al., 1979, cited in Goodman and Troake, 1982), no benthic organisms survived within a 15 m radius of the produced water discharge in water depth of 2-3 m. Low benthic biomass extended to a distance of 150 m from the outfall; no adverse effects were observed at 455 m.

Concentrations of trace metals in produced waters typically exceed those concentrations found in seawater by an order of magnitude or more (Tables III-2, IV-11, and IV-12). In a review of environmental aspects of produced waters, Koons et al. (1977) cite an increasing body of evidence which indicates that natural processes reduce the activity and toxicities of trace metals dissolved in seawater as a result of binding with organic substances. The low toxicity of trace metals is substantiated by bioassay studies which indicate that most marine organisms tolerate relatively high concentrations of produced waters. However, bioaccumulation of metals and subsequent sublethal effects remain areas of potential environmental concern. The existing data, however, neither confirms nor denies the potential for bioaccumulation of trace metals.

Marine flora and fauna may be affected by several other components and properties of produced waters, including its high salinity, temperature, content of organic compounds, low DO content, and radionuclides; however, all investigators have agreed that rapid dilution and turbulence at the discharge point limit the zone affected by these properties (e.g., Mackin, 1973; Gallaway, 1980; and Bender et al., 1979; and Reid, 1980). Although the distance required prior to the background levels being reached will vary with volume of produced water discharged and its particular characteristics, several investigators suggest that these levels are reached within a few meters from the discharge point, even in relatively shallow waters.

Offshore water quality degradation will occur within the immediate vicinity of exploration and production sites with high impacts expected to occur within a few meters to tens of meters from the discharge source. These impacts, however, will decrease to very low with distance (500-1,000 m) from the source.

Conclusion

As a result of the proposed action, the impact to offshore water quality in the Central Gulf is estimated to be low.

Cumulative Impacts

In addition to the impacts discussed for the proposed action, impacts from existing Federal OCS oil/gas leases and activities (Table IV-6); existing oil/gas leases and activities in State tidelands; tankering of petroleum products and foreign crude oil; and other commercial, military, and recreational offshore activities (Section IV.A.2.c.) should be considered as cumulative impacts on offshore water quality.

Increased oil/gas exploration and development activities in the Central Gulf will contribute to the cumulative impacts on offshore water quality in this region. These activities, along with ocean dumping and increased vessel traffic, are among the contributions to areawide offshore water quality degradation.

Approximately 165 mobile rigs and 2,800 platforms (multiwell) currently operate in the Central Gulf Federal OCS. The addition of some 2,554 exploration/delineation wells, 3,271 development/production wells, 273 platforms, and 1,350 miles of pipelines are estimated for this area as a result of Federal OCS activity related to the proposed action, future and prior OCS sales. This could result in the discharge of up to 5.6 billion bbls of formation waters, 26.5 million bbls of drilling muds, 2.98 million yds^3 of drill cuttings, and an average of 1.15 million gallons/day of treated sanitary and domestic wastes from platforms. Pipeline-related activities could result in the disturbance of up to some 8.1 million yds^3 of sediment.

Offshore waters will, therefore, be subject to cumulative impacts from discharges of drilling fluids, formation waters, and other effluents which add burdens of both toxic and non-toxic materials to the water column. However, the natural processes of dispersion, degradation, and sedimentation will result in immeasurably low concentrations of these materials within a few meters to a few kilometers of the discharge site, resulting in low impacts.

The following discussion of other factors which may cumulatively impact offshore water quality has been taken from NOAA's National Marine Pollution Program Plan dated 1981 (USDC, NOAA, 1981a).

Dredging of new channels and maintenance dredging of existing channels are required to provide safe and efficient navigation conditions for commercial and recreational marine transportation. Channel dredging generates significant amounts of dredged material consisting of the sediment and water mixture excavated from areas dredged. On the basis of volume, dredging is the largest single source of material that is ocean dumped. During 1979, more than 72 million cubic yards of dredged material was deposited in the marine environment (U.S. Dept. of the Army, Corps of Engineers, 1980). Of that total, 68% was disposed of in the Gulf of Mexico. The total constituted nearly eight times the combined tonnage of industrial wastes, sewage sludge, construction debris, and other waste materials disposed of in the marine environment during 1979 (U.S. Dept. of the Army, Corps of Engineers, 1980). Compared with other materials that are disposed of in the ocean, most of the dredged material excavated in the United States is relatively innocuous, in many instances containing no harmful pollutants and, in most of the remaining cases, containing only trace levels of contaminants. In these cases, the primary concern associated with disposal of the relatively innocuous materials centers around the direct physical effects of disposal. These physical effects include burial of organisms, increased levels of suspended sediments, and accretion of disposed materials (U.S. Dept. of the

Army, Corps of Engineers, 1978). However, dredged material taken from highly polluted areas is usually contaminated with harmful chemical constituents such as heavy metals, synthetic organics, and oil and grease. Open-ocean disposal of these materials carries the threat of acute or chronic toxic effects on marine organisms, and potential contamination of human food resources. Much research has been conducted to describe the effects of dredged material disposal in the marine environment, and to evaluate disposal options that may be preferable to ocean dumping.

Industrial wastes may contain potentially harmful constituents including synthetic organics, heavy metals, and oil and grease. Commonly used disposal options for industrial wastes are secure landfills, ocean dumping, pipeline discharges to coastal and inland waters, and incineration. When industrial wastes are ocean dumped, the waste materials are barged to a designated disposal site and discharged. Between 1973 and 1978, some 2.6 million tons of industrial wastes were dumped into the Gulf of Mexico; however, there has been a trend toward reduction of total ocean dumping of industrial wastes since 1973 when ocean dumping became regulated by the Federal Government and industrial waste dumping has been totally eliminated in the Gulf of Mexico.

The first incineration at sea of chemical waste officially sanctioned in the U.S. occurred in the Gulf of Mexico between October 1974 and January 1975 when M/T Vulcanus incinerated 16,000 metric tons of organo-chlorine wastes at a designated site about 140 nautical miles southeast of Galveston, Texas (U.S. Environmental Protection Agency et al., 1980). In 1977, 17,600 tons of chemical waste were incinerated in the Gulf of Mexico. From studies of these early burns, it has been concluded that incineration at sea for organic chemical wastes does not cause unacceptable environmental consequences, at least on a limited basis for some chemicals and at these specific sites (U.S. Environmental Protection Agency et al., 1980). Candidate wastes for incineration at sea are generated primarily by the following industries: petroleum refining, organic chemical production, synthetic fibers and resins manufacture, and pesticides production. Although incineration at sea has been conducted on a limited basis, it is likely to become more common in the future. Increasing amounts of industrial waste are produced each year, and increased regulatory pressure through implementation of the Resource Conservation and Recovery Act (RCRA) is eliminating some of the traditionally used land-based disposal options because of potential environmental hazards.

Contaminants from marine transportation activities enter the sea intentionally as a result of routine operational discharges, and unintentionally as a result of accidental spills. Vessel sizes and designs are as varied as their functions. They range from small recreational craft used primarily in coastal waters to defense-related naval vessels and ships of the merchant marine fleet up to several hundred thousand tons in size. With respect to ships that maintain sizeable crews, the pollutants are the large amounts of domestic waste products such as sewage, food waste, and trash from the human activities on board. For recreational vessels, sewage disposal from marine sanitation devices in highly populated, confined harbors and anchorages is the primary pollution concern. Other problems are related to the movement of crude oil and concern offshore unloading terminals (deepwater ports) and identification of systems most reliable for transfer of oil from OCS production areas to shoreside facilities.

Perhaps the most publicized source of pollution is operational discharge of oil by tankers in the merchant marine fleet. Because tankers cannot safely navigate ocean waters with empty tanks, they take on seawater as ballast after the cargo is discharged. When a ship gets close to its loading destination, the ballast water is discharged to make room for the oil cargo. Thus the ballast seawater, contaminated with oil from the previous cargo or from tank washing, is sometimes intentionally discharged into the ocean. In 1979 alone, an estimated 2.5 million gallons of petroleum hydrocarbons were discharged from ships operating within the Gulf, under normal operating conditions (USDC, NOAA, 1985). Regulation, coupled with the increased value of oil, has led to development of new and better techniques such as segregated ballast, crude-oil washing systems, and oil/water separation systems for minimizing contamination of ballast water. Nevertheless, enforcement of regulations and standards is still a problem.

Oil spills are one of the most highly visible forms of ocean pollution. Recently, it has been recognized that spills of hazardous materials may, in many cases, pose a more serious threat to marine ecosystems than oil spills. Substantial amounts of oil and hazardous materials enter the marine environment as a result of accidental spills. Although the focus in the past has been on the cleanup and mitigation of spilled oil, national concern has been shifting toward hazardous materials as the cause for most immediate concern. Much has been learned in the past 10 years about how to respond to oil spills; far less is known for oil spills of hazardous material. Unlike oil, whose properties are fairly uniform, hazardous materials have a wide variety of physical and chemical forms, complicating and making much more difficult the response necessary for their cleanup and disposal. Methods for the cleanup and mitigation of hazardous materials are not well established.

Between 1946 and 1970 the Atomic Energy Commission (AEC) licensed the dumping of more than 86,000 containers of low-level radioactive wastes at 28 recorded dumpsites in the Atlantic and Pacific Oceans and the Gulf of Mexico. Of these, only two dumps were made in the Gulf of Mexico (U.S. Environmental Protection Agency, 1980). Ocean dumping was discontinued in June 1970 following a policy recommendation by the President's Council on Environmental Quality (CEQ) in its 1970 report to the President. The United States has never disposed of its high-level wastes in the oceans, and in 1972 two major legislative initiatives were enacted prohibiting future disposal of high-level wastes into coastal waters and rivers. The Ocean Dumping Act, in addition to regulating ocean disposal of low-level waste, prohibits the dumping of high-level waste and radiological warfare agents in ocean waters. Soon after the Ocean Dumping Act was enacted, the Clean Water Act was amended to extend the prohibition to all navigable waters. Although not immediately contemplated, subseabed emplacement of high-level radioactive wastes is a future option.

A concentrated brine solution needing disposal results from the development and operation of salt dome storage cavities associated with the Strategic Petroleum Reserve Program (SPRP), which is mandated by the Energy Policy and Conservation Act of 1975 (42 U.S.C. 6201 et seq.). The brines are normally discharged into the Gulf of Mexico through diffusers to promote rapid dilution to background salt concentrations. However, the brines are denser than seawater and tend to flow along the seafloor, affecting bottom-dwelling organisms until sufficient dilution has been achieved. In addition, hydrocarbons and other harmful constituents may be dissolved in or entrained with the brine discharge. Brine discharges are regulated by USEPA under NPDES.

Conclusion

The overall cumulative impacts on offshore water quality in the Central Gulf, past and future oil and gas development, can be expected to be very high.

(b) Onshore

The construction and operation of onshore facilities supporting OCS activities in the Gulf may impact local onshore water quality by increasing the number of point and nonpoint pollution sources. Increases of nonpoint waste sources due to site runoff may contribute particulate matter, heavy metals, petroleum products and chemicals to local streams, estuaries, and bays, causing temporary elevations in pollutant and turbidity levels. Increases of point source discharges may also contribute to effluent discharges of domestic wastewater, cooling and boiler water, process water, and in marine terminal areas, the discharge of ballast and bilge water. These are discussed in detail in Section IV.A.4.

Impact Analysis

Onshore water quality degradation will occur as a result of increased nonpoint and point sources of pollution, especially in those areas of Louisiana (Calcasieu Basin, Mississippi Delta), Mississippi (Pascagoula area), and Alabama (Mobile Bay) where water quality problems already exist. Impacts to onshore water quality will occur as a result of runoff from construction and operation of onshore facilities supporting expanded OCS activities in this region. The construction of up to 60 miles of onshore pipeline in C-1 (20), C-2 (20), and C-3 (20) and up to one new service base in C-4 will create non-point source increases in surface runoff to nearby streams and rivers. Non-point source impacts may be minimized by controlling erosional effects generated within construction site boundaries, with several of the adverse impacts being localized and prevented from having offsite impacts to water bodies in the vicinity of these activities. Any increase beyond normal background levels would be temporary and of a limited duration. Point source increases would also occur from effluent discharges related to OCS-support activities, primarily the one new service base in C-4; however, any potential adverse impact can be mitigated by Federal and State water pollution control regulations and permitting.

Accidental spillage and chronic discharge of oils and fuels, in connection with the offloading of crude from shuttle tanker and barge activities, and fueling activities associated with supply boat support may occur as a result of the proposal. Although many of the smaller chronic discharges will go unnoticed, spills of a sizeable nature could cause very high impacts to areas adjacent to the spill. Though many ports and harbors require cleanup and containment equipment near these activities, this is not a USCG requirement.

As discussed in Section IV.A.4.a., up to one-half of the produced waters generated from OCS activities could be piped ashore for treatment and discharge into coastal waters. Produced waters which are piped ashore are subject to treatment prior to discharge, according to Federal and State regulations and permitting requirements; however, it should be noted that this treatment is only used in the extraction of oil and grease contaminants. These waters may, therefore, contain high concentrations of TDS, oxygen demanding wastes, toxic heavy metals, aromatic hydrocarbons, and environmentally high levels of radionuclides. In open ocean situations the discharge of these components appears to contribute minor impacts to the surrounding discharge area; however, in shallow semi-enclosed estuarine environments, impacts could be extremely high depending on the physical and biological components of each system. Additional information on location of discharge sites, daily discharge rates at each site, and the nature of the environment (background levels, etc.) in each area will be needed to determine the extent of impacts, if any.

Although onshore water quality impacts are estimated to be low, effluents discharged in connection with OCS-support facilities, suggested as having little or no impact, may be extremely damaging when released into sensitive habitats having a reduced capacity for pollution assimilation.

Conclusion

The overall impact to onshore water quality is estimated to be low.

Cumulative Impacts

In addition to the impacts discussed for the proposed action, impacts from existing oil/gas leases and activities in State tidelands and onshore (Section IV.A.2.d.) and other agricultural, municipal, and industrial activities (Section IV.A.2.d.) should be considered as cumulative impacts for onshore water quality.

Increased oil/gas exploration and development activities in the Central Gulf will contribute to the cumulative impacts on onshore water quality in this region. These activities along with current and future activities associated with State tidelands' oil and gas operations, industrial and municipal waste discharges, ocean dumping, and increased vessel traffic are among the contributions to areawide water quality degradation.

Approximately 70 platforms (multiwell) are currently operating in the Central Gulf State waters (1985). An unknown number of additional structures may be constructed as a result of resource development in State-owned coastal waters. The construction of several additional pipelines from existing lease blocks in both Federal and State waters may occur in the future as a result of increased development activities in these areas. Pipeline-related activities resulting from the proposed action, future and prior OCS sales could result in the disturbance of up to 6.9 million yds3 of sediment. The addition of up to 10 new service bases (C-1 (3), C-2 (3), C-3 (2), and C-4 (2)), possibly one new pipe coating yard in C-4, 14 new pipeline landfalls (C-1 (4), C-2 (5), C-3 (4), C-4 (1)), up to 280 miles of onshore pipeline (C-1 (80), C-2 (100), C-3 (80), and C-4 (20)), up to 3 new platform fabrication yards (C-1 (1) and C-2 (2)), and 4 new gas processing plants (C-1 (1), C-2 (1), C-3 (1), and C-4 (1)) are estimated as a result of the proposed action, future and prior OCS sales in the CPA. Onshore water quality degradation will occur primarily in subareas C-1 and C-2 as a result of increased nonpoint and point sources of pollution associated with the construction and operation of this new onshore infrastructure.

The following discussion of other factors which may cumulatively impact onshore water quality has been taken from NOAA's National Marine Pollution Program Plan dated 1981 (USDC, NOAA, 1981a).

Industrial ocean outfalls are pipeline discharges of industrial wastes that directly enter estuaries, coastal waters, or oceans. Ocean outfalls of industrial wastes are regulated by USEPA through NPDES. In 1979, more than 5,000 NPDES permits were held for pipeline discharges by industries in coastal counties. In addition, about 7,500 operational discharges were associated with offshore oil and gas facilities. Pollutants that may be associated with various industrial effluents include synthetic organic, heavy metals, oxygen-consuming materials, suspended solids, and nutrients. Over one-half (63 million lb/yr) of all oil discharges comes from industrial point sources. The chemical and allied products and petroleum refining, and related industries combined represent 90% of all oil discharges from industrial point sources. The counties with the greatest volume of oil discharged from industrial point sources include Jefferson, Harris, and Brazoria Counties in Texas, and Calcasieu, St. Charles, and Ascension Parishes in Louisiana (USDC, NOAA, 1985).

Historically, the Nation's rivers, estuaries, and coastal waters have received municipal waste discharges since collection and treatment of domestic wastes was initiated. Prior to the 1970's, ocean disposal was largely unregulated, and adverse impacts on human health and the environment were observed. The principal hazards to human health from sewage waste disposal are associated with the transmission of human pathogens and the ingestion of seafoods contaminated with toxic metals and synthetic organic compounds. Food poisoning, dysentery, and transmission of a variety of human and animal parasites are commonly associated with the discharge of untreated sewage waste. Other adverse impacts are the loss of recreational and commercial resources where beaches or wetlands are fouled with floating waste materials or are closed to fishing and shellfishing because of sewage contamination.

Although major attention is given to these highly visible accidents, substantial amounts of oil and hazardous material enter the marine environment through far less spectacular means. Spillage during loading and unloading operations in ports and harbors, pipeline leakage, equipment failures, spills from land vehicles and storage facilities onshore are all sources and causes of accidental discharges that eventually enter the marine environment. Oil contained in urban and river runoff (spent oil and grease that wash from the streets and sewers of cities) are major contributors to the oil content of the oceans. About 35% of the total annual oil pollution added to the seas is a result of accidental discharges from oil transportation (by tankers, pipelines, barges, etc.) (NAS, 1981). A small amount enters from OCS activities (less than 2%). The remainder enters from coastal facilities and wastes, land runoff, and natural seeps.

The operation of some coastal facilities can result in large accidental spills, or chronic unintentional discharges of harmful substances into coastal waters. For example, it is estimated that, on the average, each fueling of a pleasure craft at a recreational marina results in the spillage of one fluid ounce of gasoline or diesel fuel (Richardson et al., 1975). Oil and grease also enter the waters around a marina in bilge discharge and as a result of lubrication and maintenance. The effects of chronic discharges may become locally important in areas where coastal facilities occur at high densities, or when major portions of the coastal area are affected.

Nonpoint source pollution is among the most challenging of water pollution problems. In contrast to the important progress made in controlling industrial point source discharges and in upgrading municipal sewage treatment facilities, progress with nonpoint sources is negligible (CEQ, 1980). The distinction between point and nonpoint sources of water pollution is not always clear. Point sources generally discharge into surface waters through a discrete pipe, outfall, or ditch, and nonpoint sources generally discharge in a more diffuse way, for example, land runoff. Nonpoint source pollution is primarily the result of precipitation falling and moving over and through land and into surface water bodies. In some cases nonpoint source pollution is the result of human practices, for example, irrigation. All land use activities are potential nonpoint sources of pollution. Nonpoint sources of pollution are classified as urban and non-urban runoff. Urban runoff occurs in areas of relatively high population density that are largely impervious to water because of the large area covered by roads, sidewalks, parking lots, and buildings. Urban stormwater runoff in American coastal counties is approximately 5.3 billion gallons per day. Some 40 million lbs of BOD and 30 million lbs of petroleum hydrocarbons are discharged into the Gulf from urban runoff each year. Orleans Parish in Louisiana has the highest rate of runoff per mi^2 in the region, while Harris County in Texas has the next highest rate (USDC, NOAA, 1985). Non-urban runoff occurs in all land areas other than urban, such as agricultural lands, animal feedlots, pasture land, and forest land. Non-urban areas are more previous than urban areas and absorb a higher percentage of precipitation into the soil. Stormwater runoff from urban and nonurban sources discharge over 40 million lbs/yr of phosphorous directly into surface waters in coastal counties. About 90% of this is associated with sediment losses from agricultural cropland. Coastal counties with the greatest direct discharges from nonpoint sources include Nueces, Victoria, and Jackson Counties in Texas, and Acadia, Vermilion, and Lafourche Parishes in Louisiana (USDC, NOAA, 1985). The effects of nonpoint sources on water quality can be significant, depending on the annual hydrologic cycle and the types of land uses within a region. Estuaries and adjoining coastal areas may be particularly affected. Nearly the entire United States is drained by river systems that eventually discharge into coastal waters. Depending on the pollutants and the characteristics of the river system they enter, various amounts of nonpoint source pollutants are ultimately discharged into coastal waters. Water pollution from nonpoint sources is estimated to affect about 90% of the drainage basins in the United States (U.S. Environmental Protection Agency, 1978). Pollution discharges from nonpoint sources greatly exceed the discharges from point sources. In fact, it has been concluded (U.S. Comptroller General, 1977) that national water quality goals cannot be achieved without some control of nonpoint source pollution.

Other factors considered to cumulatively impact nearshore and onshore waters include the discharge of dredge materials, industrial waste discharges, vessel discharges, and oil spills. These are discussed under the cumulative section for offshore water quality.

Nearshore waters will therefore be subject to cumulative impacts from discharges of drilling fluids, formation waters, and other effluents which add burdens of both toxic and non-toxic materials to the water column.

Conclusion

The overall cumulative impacts for onshore water quality in the Central Gulf can be expected to be very high, primarily in those highly urbanized and industrialized coastal areas currently experiencing water quality problems.

(4) Impacts on Air Quality

The major impact producing factors on air quality from OCS-related activity are due to combustion, evaporation, or venting of hydrocarbons. In the offshore environment, potential impact producing activity includes catastrophic events and operational emissions.

In the onshore environment, potential impact producing activity includes the operation of oil refineries, gas processing plants, and vessel loading. These are discussed further in Section IV.A.4.

Definitions of expected levels of impact related to air quality are listed below; five impact levels are defined. Significant concentrations relative to these definitions are detailed in Tables IV-39, IV-40, and IV-41 of the Final Regional EIS.

Very High - OCS-related offshore or onshore sources significantly increase levels of criteria pollutants such that nonattainment areas will be degraded further or attainment and PSD areas are significantly degraded.* Significant effects on public health and welfare are expected.

High - OCS-related offshore or onshore sources increase levels of criteria pollutants such that nonattainment areas are likely to be degraded less than significantly, or attainment and PSD areas are likely to degrade.* Likely to pose hazards to public health and welfare.

Moderate - OCS-related offshore or onshore sources increase levels of criteria pollutants such that nonattainment areas are likely to experience minor degradation and attainment and PSD areas are not likely to degrade significantly.* Unlikely to pose hazards to public health and welfare.

Low - OCS-related offshore or onshore sources increase levels of criteria pollutants such that nonattainment areas are unlikely to be degraded further and attainment and PSD areas are likely to undergo only very small increases in levels of criteria pollutants.* Very unlikely to pose hazards to public health and welfare.

Very Low - OCS-related offshore and onshore sources increase levels of criteria pollutants such that nonattainment areas are very unlikely to be degraded further and attainment and PSD areas are likely to undergo negligible increases in levels of criteria pollutants.* Does not pose any hazard to public health and welfare.

*Note that levels of degradation of PSD areas are relative to whether they are a Class I, Class II, or Class III area; i.e., very small changes in pollutant levels are considered significant for Class I areas. (Refer to Tables IV-39, IV-40, and IV-41 of the Final Regional EIS for significance levels relative to the above definition and PSD areas.)

Impact Analysis

The ambient air quality in the CPA is generally considered better than the national standards with violations of the NAAQS occurring in some coastal areas; these areas where violations occur are designated as nonattainment areas. Additionally, there is one PSD Class I area in the coastal region (Breton Wilderness Area) whereby a small amount of degradation to ambient air quality is considered significant. All nonattainment and PSD Class I areas in the CPA are identified below:

St. John the Baptist, Louisiana
  Nonattainment - Primary - Ox
Orleans, Louisiana
  Nonattainment - Primary - Ox
Jefferson, Louisiana
  Nonattainment - Primary - Ox
St. Bernard, Louisiana
  Nonattainment - Primary - Ox
St. Charles, Louisiana
  Nonattainment - Primary - Ox
Lafourche, Louisiana
  Nonattainment - Primary - Ox
St. Mary, Louisiana
  Nonattainment - Primary - Ox
Mobile, Alabama
  Nonattainment - Primary - Ox
  Primary and Secondary TSP
St. Bernard/Plaquemines, Louisiana
  PSD Class I - Breton Wilderness Area

Onshore, it is expected that no new gas processing plants and no new crude oil refineries will be needed to handle additional needs. Offshore, 320 exploration and delineation wells, and 408 development wells are estimated to be drilled and 34 additional production platforms utilized.

Catastrophic events such as major oil spills and blowouts have the potential to create localized air quality problems. Table IV-42 of the Final Regional EIS shows that a major oil spill (10,000 bbl magnitude of light crude) could emit 570,000 lbs/hr of hydrocarbon the first hour and 290,000 lbs/hr the second hour. As discussed in Section IV.B.3. and as shown in Table IV-20 of the Final Regional EIS, 45% of a spill is expected to be lost due to evaporation of hydrocarbons over the first 10 days. In the Central Gulf, one major oil spill greater than 1,000 bbls is expected to occur as a result of the proposed action. Degradation of onshore air quality is not expected due to this oil spill. The probable distance from shore (more than 3 miles and very likely farther), rapid dispersion or breakup associated with oil spills, and the turbulent variable surface winds offshore are natural conditions that minimize oil spill effects. Rapid dispersion of evaporative emissions from these sources is expected. There is a possibility that a major spill occurring near land under ideal conditions (steady onshore winds, persistent spill) could cause short-term onshore air quality degradation. If this were to occur adjacent to a nonattainment or PSD Class I area, this short-term degradation would be more serious than if it occurred elsewhere.

Catastrophic events are not possible to predict in time and location. Effects from these nonroutine activities are highly dependent on the distance offshore, H_2S content, and proximity to a nonattainment or PSD area. Higher impacts will occur if these events affect nonattainment or PSD Class I areas (see Section IV.A.4. for further discussion).

In an attempt to estimate the amount of operational emissions produced as a result of Sale 110 for a peak year of activity, air emissions data were compiled for exploratory drilling and platform operations. Typical emissions for exploratory drilling are shown in Table IV-14 and are based on studies conducted by USEPA for offshore activities. Emissions for a major platform operation is presented in Table IV-15. Emissions shown in this table are based on five years of air emissions data submitted to MMS in the Gulf of Mexico by industry operators.

Table IV-28 displays air emissions estimates under the proposed action using M Scenario assumptions. Since the greatest impacts would result during the period of highest activity, estimates are made for the peak activity years. A total of estimated emissions resulting from the proposed action is provided. The volume estimated assumes all activity occurs in the same peak year. Since all peak years are not conterminous, the estimate is assumed to be high. It should be noted that the total emissions estimated in Table IV-28 are based on values provided in Tables IV-14 and IV-15 and are not based on a detailed inventory of located emissions.

Table IV-28

Air Emissions For Peak Years Under M Scenario Assumption
Central Planning Area
(tons/year)

	NO_x	CO	SO_x	VOC	TSP	Number of Wells/ Platforms	Peak Year
Proposed Action							
Exploratory Drilling	772.5	113.3	51.8	25.5	-	75	1990
Development/Production							
Drilling	618.0	90.6	41.4	20.4	-	60	1992
Platforms[1]	540.0	121.0	126.0	16.0	7.5	5	1992
Total	1,930.5	324.9	219.2	61.9	7.5		

[1] Assumes all platforms are major platforms capable of producing emissions.

The impact of OCS emissions resulting from the proposed action cannot be measured with available information. The spacial distribution of rigs and platforms, the temporal distribution over time, and the specific equipment producing emissions are unknown. However, it is assumed the proposed action is expected to create a relatively even distribution of activity throughout the Central Gulf with the greatest activity in subplanning area C-2 and the least activity in C-4. The number of wells drilled and platforms installed are estimated in Table IV-4. Emission controls or offsets are not expected to be necessary for offshore facilities.

Of these coastal parishes/counties adjacent to the majority of annual offshore development, the ones most likely to be adversely impacted by this activity due to their unique status as nonattainment or having PSD Class I areas are: St. John the Baptist, Orleans, Jefferson, St. Bernard, St. Charles, Lafourche, St. Mary, and Plaquemines Parishes, Louisiana.

The expected levels of activities adjacent to these parishes are not large. These activities are not expected to occur simultaneously and are not expected to cause impacts above the level defined as low. Low impacts can be based solely on the amount of activity expected to occur, i.e., nonattainment areas are unlikely to be degraded further.

Additionally, no significant deterioration of onshore air quality is expected from routine offshore operational emissions due to the regulatory control provided in 30 CFR 250.57. These regulations limit emissions from OCS facilities relative to significance levels outlined in Tables IV-39 and IV-40 of the Final Regional EIS. The regulations require that individual analysis of emissions produced by proposed structures in the Gulf of Mexico be performed. Since 1980 this analysis has shown that no structure proposed to date will exceed the exemption level. These regulations insure that impacts do not rise above an upper level (moderate) and will be considered nonsignificant. Impacts are controlled by regulations in this case such that public health and welfare are protected at an acceptable level. Impacts from uncontrolled (nonroutine) events could be higher. The expected duration of impacts and a summary of expected impacts on the resource of concern are presented in Table IV-29.

Conclusion

Moderate impacts are expected in St. Bernard, Plaquemines, St. Mary, Lafourche, St. Charles, Jefferson, Orleans, and St. John the Baptist Parishes in Louisiana and Mobile County in Alabama. Very low impacts are expected throughout the remainder of the coastal area of the Central Gulf and in Escambia County in the Eastern Gulf.

Table IV-29

Summary of Expected Impacts on Air Quality - Proposed Action
Central Planning Area

Major Impact Producing Factor	Expected Impacts Onshore	Duration of Expected Impacts
Offshore Activity		
Catastrophic Events		
Blowouts with fire	Low to moderate	Short-term
Oil spills (major)	Low to moderate	Short-term
Release of sour gas (nonflared blowout)	Moderate to high	Short-term
Operational Emissions		
Exploration drilling	Low to moderate	Long-term
Platform installation	Low to moderate	Long-term
Development drilling	Low to moderate	Long-term
Oil production	Low to moderate	Long-term
Gas production	Low to moderate	Long-term
Tankering	Low	Long-term
Onshore Activity		
Operations Emissions		
Refineries	No new expected*	Long-term
Gas processing plants	No new expected*	Long-term
Vessel loading	No new expected*	Long-term

*Impacts from these activities are maintained below an upper limit (moderate) due to standing regulatory controls.

Note: Specific changes in conditions relative to levels of impacts are defined at the beginning of this section. Short-term is less than one year. Long-term is more than one year.

Cumulative Impacts

In addition to the impacts discussed previously for the proposed action, impacts from existing Federal and State oil/gas leases and activities (Section IV.A.2.); tankering, vessel traffic, storage facilities, and refining of petroleum products and foreign crude oil; and other industrial, municipal, and mobile emissions should be considered as cumulative impacts on air quality.

Point source emissions from onshore activities, such as non-OCS oil and gas processing, power generation facilities, industrial processing or manufacturing facilities, waste incineration facilities, petrochemical storage facilities and mobile emissions sources (automobiles, waterborne transportation, etc.), are expected to increase at rates in proportion to the growth of population. Energy conservation, improved automobile emission controls, alternative (non-fossil fuels) energy generation facilities, and new waste disposal technology are factors that will determine the rate of change in air quality. Due to population in-migration throughout the Gulf region, the ambient air quality will probably degrade, over time, due to the overall effects of these activities and OCS-related activities. Ambient air quality is not expected to degrade beyond attainment standards where it is currently better than those standards or where PSD areas are located. The effects of all emissions on areas presently classified as nonattainment will be reduced over time so that attainment standards will be met. Controls and offsets may be applied to emissions sources to meet these standards.

By far the most important OCS-related impact may be the cumulative effect of operational emissions on the coastal regions. Presently, a Gulf of Mexico study is underway to analyze inputs by use of the Offshore Coastal Dispersion (OCD) Model. This model will simulate the cumulative effects downstream of up to 250 point sources under various climatological conditions. Two major kinds of input data are required to drive the OCD Model: meteorological data and point source air emissions data. Currently, a Gulfwide air emissions inventory is being collected. The data is expected to be compiled by early 1987. Meteorological data will be available as needed.

An estimate of total emissions to be produced over a 20-year period is shown in Table IV-30. This estimate includes OCS infrastructure/activity assumed to be generated in the future by previously leased oil and gas resources in the CPA and by existing platforms in place. Existing platform distances to shore may range from 3 to over 150 miles. An average annual figure is given.

Table IV-30

Twenty Year Cumulative Estimated Offshore Air Emissions
Central Planning Area
(1,000 tons)

	NO_x	CO	SO_x	VOC	TSP	Number of Wells/Platforms
Leased Resources Expected to be Developed						
Exploratory Drilling	26.3	3.9	1.8	0.8	-	2,554
Development Drilling	33.7	4.9	2.2	1.1	-	3,271[1]
Platforms	14.8	3.3	3.4	0.4	0.04	137[1]
Subtotal	74.8	12.1	7.4	2.3	0.04	
Existing Platforms	151.2	33.8	35.2	4.5	0.40	1,400[1]
Total	226.0	45.9	42.6	6.8	0.40	
Average Annual	11.3	2.3	2.1	0.3	0.02	

[1] Assumes 50% of existing structures are major platforms.

No new oil refineries and four new gas processing plants will be required as a result of the proposed action. It is assumed that new source performance standards and best available control technology will be used on all onshore facilities. It is assumed that additional controls or offsets may be required in some areas to meet air quality standards imposed by existing regulations. It can be assumed that impacts will be their highest (relatively) in the following parishes/counties which are classified as nonattainment or PSD Class I areas: St. John the Baptist, Orleans, Jefferson, St. Bernard, St. Charles, Lafourche, St. Mary, and Plaquemines Parishes, Louisiana; and Mobile County, Alabama.

It must be noted that these areas identified are nonattainment areas for a specific pollutant (Ox and TSP). Gas processing produces specific SOx emissions only. Therefore, these activities will not be a significant contribution to the identified parishes/counties, except that these activities may use an increment of the allowable SOx limit.

Offshore infrastructure in the CPA is estimated to be 2,800 platforms. Emissions for OCS installations is calculated at the time of permitting production facilities. Such factors as the distance to shore, climatological conditions, and emissions producing equipment on each platform is analyzed as to its contribution to degradation of air quality. Since records have been kept (June 1980), this air quality permitting analysis has identified a negligible contribution in the CPA.

Conclusion

The cumulative impacts to air quality in the Central Gulf will be moderate.

(5) Impacts on Endangered and Threatened Species

The definitions of impact levels for endangered and threatened species are as follows:

Very High	- A population declines in the affected area resulting in a change in the distribution and/or abundance (greater than 5%) of the species in the local area and/or the planning area. The expected duration of the effects within the local area and/or the planning area is more than three generations* or 10 years or more.
High	- A population declines in the affected area resulting in a change in the distribution and/or abundance (less than or equal to 5%) of the species in the local area and/or the planning area. The expected duration of the effects within the local area and/or the planning area is two or three generations or 6-9 years.
Moderate	- A population declines in the affected area resulting in a change in the distribution and/or abundance (less than or equal to 1%) of the species in the local area and/or the planning area is one generation or 3-5 years.
Low	- A population declines in the affected area resulting in a change in the distribution and/or abundance of the species in the local area and/or the planning area. The expected duration of the effects within the local area and/or the planning area is less than one generation or 1-3 years.
Very Low	- No discernible lethal effects, but individuals experience sublethal effects which cause reduced biogenic activity or reduced metabolic functions. Organisms would recover to pre-impact condition in less than one generation or 1-2 years.

*A generation is the term of years accepted as the average period between the birth of the parents and the birth of their offspring.

An endangered species consultation pertaining to proposed Gulf of Mexico oil/gas lease sales was held with FWS and NMFS. The biological opinions from these agencies (Appendix C) indicate that leasing and exploration activities associated with the proposed action are not likely to jeopardize the continued existence of the listed species considered in the consultations or result in the destruction or adverse modification of their critical habitats. On January 29, 1986, a memorandum from the FWS Southeastern Regional Office concurred with MMS's December 30, 1985, determination that proposed Sales 110 and 112 do not represent a substantive modification of the proposed actions considered in earlier regionwide consultations and that formal consultation for these proposed sales need not be initiated at this time. Minerals Management Service is requesting a reinitiation of Section 7 consultation with NMFS to inspect new data that has recently been generated concerning marine turtles.

(a) Brown Pelicans

Impact Analysis

The major impact producing factors which could affect brown pelicans in the CPA include OCS-related oil spills, noise disturbance from aircraft and vessel traffic, and pipeline placement and coastal facility construction near nesting and feeding areas.

If an oil spill should occur and contact brown pelican nesting and/or feeding areas, the pelicans could suffer mortality or reduced reproduction capacity. Pelicans are vulnerable to oil spills because as they plunge-dive during feeding or rest on the water, an oil slick could contaminate their feathers. This could result in the ingestion of oil as the feathers are preened or oil could be ingested during feeding. Should the food source itself be contaminated with oil, additional oil may be ingested. Ingestion of oil has been shown to cause reproductive losses in many bird species (Section IV.B.). Oil coming in contact with nesting areas could also result in oiling of feathers and contamination of eggs or chicks, resulting in mortality.

There are four major feeding and nesting sites inhabited by brown pelicans in the Central Gulf coastal area. One site is located in the vicinity of Queen Bess Island in Lafourche Parish, Louisiana. A site is located in the vicinity of North Island in St. Bernard Parish, Louisiana. A small site is located near the mouth of the Pearl River in Hancock County, Mississippi. Another small site is located on Gaillard Island (near Theodore) in Mobile County, Alabama.

The pelican feeding and nesting habitat in Lafourche and St. Bernard Parishes have a 2% chance and Hancock and Mobile Counties have less than a 0.5% chance of being contacted by oil spills as a result of the proposed action. Due to the low chance of oil spill contact, the expected level of impact to brown pelicans from oil spills is very low.

Noise disturbance from aircraft and vessel traffic during nesting season can cause pelicans to leave or abandon their nests, which could result in the loss of eggs and mortality of chicks and/or juvenile birds. About 8,900 OCS-related vessel trips are estimated to occur in the CPA as a result of the proposed action; this is 3% of the total vessel traffic in the Central Gulf. Only the nesting site in Lafourche Parish is likely to experience moderate numbers of OCS-related aircraft and vessel traffic. This traffic usually does not approach close enough to nest sites to disturb pelicans because of minimum altitude restrictions and shallow water depth. The expected impact on brown pelicans from noise disturbance as a result of the proposed action is very low.

The placement of pipelines and the construction of onshore facilities near pelican feeding and nesting sites not only removes habitat available for nesting sites, but also noise associated with human activity make additional areas unavailable for nesting. One pipeline is estimated for subareas C-2 (St. Mary, Terrebonne, or Lafourche Parishes) and C-3 (Jefferson, Plaquemines, or St. Bernard Parishes). If a pipeline is emplaced in Lafourche or St. Bernard Parishes near nest sites during the spring nesting season, there could be some disturbance which could result in some mortality of pelicans. Pipeline construction in Lafourche or St. Bernard Parishes during the balance of the year would have a very low impact on pelicans.

One service base is estimated for subarea C-4 (the Long Beach-Biloxi, Pascagoula, or Mobile-Bayou La Batre areas). It is likely the service base would be located in or near a port area. The only pelican rookery near any of these potential sites (Mobile) is the rookery on Gaillard Island in Mobile Bay. This rookery is unlikely to be affected by any of the above service base locations.

Conclusion

A very low level of impact on brown pelicans and their feeding and nesting habitat is expected in the Central Gulf as a result of the proposed action.

Cumulative Impacts

In addition to the impacts discussed previously for the proposed action, the effects of existing Federal OCS oil/gas leases and activities; existing oil/gas leases and activities in State tidelands; tankering of imported crude oil; and other commercial, military, and recreational offshore and coastal activities are considered in the cumulative impact analysis.

The estimated cumulative number of oil spills from the proposed action, existing OCS leases, and future OCS lease sales in the CPA is 16, and the tankering of crude oil imports would add about 24 oil spills greater than 1,000 bbls and several smaller spills. Plaquemines Parish, Louisiana, is the area with the highest probability of contact (89%) due to the extensive OCS and State oil development in the Mississippi Delta area and the tankering of crude oil and products on the Mississippi River. Also, there are high levels of oil and organic chemical contamination in the river water and sediments. There are three brown pelican rookery areas within this general area. The cumulative impact of oil spills and probable water and food contamination is expected to result in a moderate level of impact on brown pelicans in the CPA.

Disturbance from aircraft and vessel traffic in the vicinity of pelican nesting areas in the CPA is not likely to increase above current levels as a result of offshore oil/gas activities. About 97% of the boat and ship traffic in this area is non-OCS-related traffic such as: commercial tanker/cargo vessels; commercial and recreational fishermen; intracoastal tug and barge traffic; and maintenance dredging operations.

Estimates of cumulative offshore-related oil/gas onshore development and support facilities (Table IV-6) are: 10 service bases, 1 pipeline installation base, 1 pipe coating yard, 14 pipeline landfalls, 280 miles of onshore pipeline, 3 platform fabrication yards, and 4 gas processing plants requiring an estimated 5, 115 acres in the CPA coastal region. Other commercial and recreational construction and dredging in the coastal wetland areas could result in hydrologic changes and habitat alteration, which could impact brown pelican habitat and food sources.

Impacts that are unrelated to offshore activities, which are difficult to quantify, but are major contributors to cumulative impact on brown pelicans would include the loss of habitat to commercial, military, recreational, and residential development in the coastal zone; dredging and draining of wetlands and coastal feeding/nesting areas; high levels of oil and organic chemical contamination of coastal waters and food sources; agricultural runoff and industrial wastes; the disturbance from aircraft and vessel traffic in nesting and feeding areas; entanglement in commercial and recreational fishing gear; collision with power lines and towers (Avery et al., 1980); and coastal storms and hurricanes cause flooding and destruction of nesting areas.

Conclusion

The cumulative impact on brown pelicans is estimated to be moderate.

(b) Marine Mammals (Whales)

Impact Analysis

The major impact producing agents which could potentially affect whales include offshore oil/gas-related oil spills, collision with OCS-related support boats, and disturbance from OCS-related oil/gas activities.

Based on laboratory research (Geraci and St. Aubin, 1982; Goodale et al., 1981; and Gruber, 1981), the most likely effects of oil on endangered whales are: (1) a mild deleterious but reversible effect on the skin; (2) possible eye irritation, which would be reversible unless exposure was prolonged; (3) possible short-term baleen fouling with possible feeding reduction for 1 or 2 days; (4) possible blowhole fouling and death due to respiratory stress for very young animals in heavy oil; and (5) temporary food reduction or contamination, and oil ingestion by whales. Potential but unlikely effects include: (1) possible mortality due to respiratory stress; (2) possible mortality to young or already stressed animals immediately after a spill, due to ingestion of oil or inhalation of vapors; and (3) possible mortality due to stress of individuals that are already stressed. Mortality has not been verified for any whales due to an oil spill. Therefore, it could be assumed that, if deaths occurred, the percentage would be very low.

Although the endangered sperm whale is uncommon in the Gulf of Mexico region (Mead, 1975), it is probably the most numerous endangered whale species in this region (Table III-5). Very few whales have been sighted in the CPA (Fritts et al., 1983). The major whale habitat in the Gulf is in deepwater, off the continental shelf, while most of the OCS oil/gas activities occur on the shelf.

The deepwater whale habitat is unlikely (less than 10% chance) to be contacted by an oil spill resulting from this proposed action, and the chance of a whale contacting an oil spill resulting from this proposed action is very low.

As a result of the proposed action, offshore oil/gas-related vessel traffic is estimated to be about 3% of the total annual vessel traffic in the Central Gulf. The level of OCS-related vessel collisions with whales in the Central Gulf is unknown; no injuries or mortalities have been reported. The level of impact to marine mammals resulting from OCS-related vessel collisions is expected to be very low.

About 320 exploration and delineation wells may be drilled, some additional seismic exploration may be required. Underwater sounds from seismic activities and well drilling apparently do not pose a significant impact to whales (Malme, et al., 1984; Gales, 1982; and USDI, MMS, 1983e). No adverse impacts resulting from these activities have been reported or documented in the Gulf of Mexico region. The disturbance is usually short-term and fairly localized near the source, and it is unlikely to cause a major impact on whales in the Central Gulf.

Conclusion

It is estimated that offshore oil/gas-related oil spills, collision with offshore support vessels, and disturbance from OCS oil/gas activities as a result of this proposed action will have a very low level of impact on whales.

Cumulative Impacts

In addition to the impacts discussed previously for the proposed action, impacts from existing Federal OCS oil/gas leases and activities; existing oil/gas leases and activities in State tidelands; tankering of petroleum products and imported crude oil; and other commercial, military, and recreational offshore and coastal activities should be considered as cumulative impacts (Section IV.A.2.). Because of the lack of data, some of these cumulative impacts cannot be quantified.

Impacts to whales in the CPA could result from an estimated 16 OCS-related oil spills (1,000 bbls or greater) and 24 oil spills estimated from Gulfwide tankering of imported crude oil. An unknown number of spills could occur in Louisiana tidelands and from the Louisiana offshore port facility. These oil spills are expected to have a low level of cumulative impact on whales in the CPA. Deepwater exploration and development on the continental slope could affect sperm whales which feed on squid in deepwater areas.

The OCS-related boat and vessel traffic estimated for the proposed action is about 3% of the annual commercial, military, and recreational vessel traffic in the offshore areas inhabited by whales. About 268,340 vessel trips of all types were recorded for the CPA in 1982, primarily into major port areas. Seismic exploration will occur on an estimated 2,554 lease blocks, and sound will be generated from an estimated 2,800 offshore platforms and 201,000 supply/crew boat and 1,551,000 aircraft trips. Additional sound is produced by commercial, military, and recreational vessels and aircraft and by commercial and military sonar. The majority of these disturbances and noises are usually localized around the source and are fairly short-term. Other cumulative impacts from disturbances and noises in other feeding/migratory areas of the Caribbean Sea and Atlantic Ocean are uncertain. The cumulative impact from these disturbances and noises are expected to be low in the CPA.

Other impacts that are unrelated to OCS oil/gas activities but contribute to a cumulative impact on whales include: entrapment, injury, and mortality in fishing gear and underwater cables. Several whale species were hunted to near extinction during the 1800's, and commercial and subsistence hunting of some whale species still continues. Ocean disposal of chemicals, radioactive wastes, munitions, etc., could contaminate whale food sources.

Conclusion

The cumulative level of impacts is estimated to be moderate.

(c) Sea Turtles

Impact Analysis

The major impact producing factors which could potentially affect sea turtles in the CPA include offshore-related oil spills, collision with support vessels, and OCS oil/gas-related pipeline construction across nesting beaches.

Occasional loggerhead nesting has occurred on the Chandeleur Islands off Louisiana and on Horn and Ship Islands off Mississippi. No green, leatherback, ridley, or hawksbill turtle nesting has been reported in the CPA. Loggerhead and Kemp's ridley turtles forage off the Louisiana coast. Data from 1985 marine turtle strandings indicate one ridley turtle for Louisiana, one green and one unidentified turtle for Mississippi, and none for Alabama (USDI, NMFS, 1986).

Oil spills contacting a turtle nesting beach during egg incubation or hatching periods (June-August) could cause significant turtle mortality (Fritts and McGhee, 1981). Offshore oil spills could have a serious impact on sea turtles. Floating oil could result in mortality of turtles by contacting the turtles when they surface to breathe and indirectly by affecting food sources.

The probability of an oil spill occurring and contacting sea turtle nesting habitat on Horn or Ship Islands of Mississippi is less than 0.5% and on the Chandeleur Islands of Louisiana is about 5% as a result of the proposed action. Very little sea turtle nesting occurs in the Central Gulf area, and considering the very low chance of an oil spill occurring and contacting turtle nesting habitat, the expected level of impact on turtle nesting habitat is very low.

There is a moderate probability (about 47%, Table IV-17) of one or more offshore oil spills occurring in the Central Gulf as a result of this proposed action. An offshore spill could contact sea turtles while they are basking, surfacing to breathe, or feeding and cause deleterious effects. Because of the low number of spills expected, about one (0.6, Table IV-19), and the low numbers of sea turtles which occur in the CPA, the probability of sea turtles contacting an oil spill offshore Louisiana as a result of the proposed action is low.

Vessel traffic related to the proposed action poses a collision threat which could cause serious injury or mortality to sea turtles. Information on the number of OCS-related boat/turtle collisions in this area is unavailable; however, no adverse effects of vessel traffic on sea turtles has been reported or documented. Considering the estimated level of offshore-related vessel traffic generated by the proposed action (3% of the annual vessel traffic) that would pass through turtle habitats in relation to the estimated numbers and temporal variability of sea turtles in these areas, the level of expected impact is estimated to be low.

Up to three pipeline landfalls are estimated, one each in coastal subareas C-1, C-2, and C-3 (Table IV-4). None of these pipeline landfalls cross beaches which are currently used for sea turtle nesting.

Conclusion

A low level of impact on sea turtles and their habitat is expected in the Central Gulf area as a result of the proposed action.

Cumulative Impacts

In addition to the impacts discussed previously for the proposed action, impacts from existing Federal OCS oil/gas leases and activities; future OCS leasing; existing oil/gas leases and activities in State tidelands; tankering of imported crude oil and petroleum products; and other commercial, military, and recreational offshore and coastal activities should be considered as cumulative impacts (Section IV.A.2.).

The cumulative number of OCS oil/gas-related oil spills (1,000 bbls or greater) that could occur is 16. In addition, oil spills could occur as a result of oil development in Louisiana tidelands and about 24 oil spills are estimated as a result of transporting crude oil imports Gulfwide. The highest probability (89%) of a large oil spill contact is in Plaquemines Parish, Louisiana, where about two oil spill contacts could occur. The area between Marsh Island and the Mississippi Delta (St. Mary, Terrebonne, Lafourche, and Plaquemines Parishes) is a major feeding area for loggerhead and ridley turtles. These oil spills could result in some sea turtle injury or mortality in this area. The expected cumulative impact of oil spill contacts on sea turtles in this area is estimated to be moderate.

Impacts that are unrelated to OCS oil/gas activities, which are difficult to quantify, but contribute to a cumulative impact on sea turtles include: the loss of nesting beaches to commercial, recreational, and residential development along Louisiana beaches; very high mortality caused by commercial trawling, commercial longline fishing gear, and entanglement in crab pot lines; natural and man-induced predation of turtles and eggs on nesting beaches throughout the Gulf of Mexico and Caribbean Sea regions; oil/tar balls from natural seeps, bilge cleaning, and tanker spills; compaction, subsidence, and flooding of nesting beaches; dumping of contaminated wastes, plastic materials, and other debris into the sea; and collision with commercial, military, and recreational vessels. In 1985, about 300 turtle strandings were reported for the Gulf of Mexico (USDC, NMFS, 1986).

Conclusion

The cumulative level of impact is estimated to be very high.

(6) Impacts on Coastal and Marine Birds

The definitions of impact levels for coastal and marine birds (non-endangered) are as follows:

Very High	- A population declines in the affected area resulting in a change in the distribution and/or abundance of the species in the local area and/or the planning area. The expected duration of the effects within the local area and/or the planning area is more than three generations* or 10 years or more.
High	- A population declines in the affected area resulting in a change in the distribution and/or abundance of the species in the local area and/or the planning area. The expected duration of the effects within the local area and/or the planning area is two or three generations or 6-9 years.
Moderate	- A population declines in the affected area resulting in a change in the distribution and/or abundance of the species in the local area and/or the planning area. The expected duration of the effects within the local area and/or the planning area is one generation or 3-5 years.
Low	- A population declines in the affected area resulting in a change in the distribution and/or abundance of the species in the local area and/or the planning area. The expected duration of the effects within the local area and/or the planning area is less than one generation or 1-3 years.
Very Low	- No discernible lethal effects, but individuals experience sublethal effects which cause reduced biogenic activity or reduced metabolic functions. Organisms would recover to pre-impact condition in less than one generation or 1-2 years.

*A generation is the term of years accepted as the average period between the birth of the parents and the birth of their offspring.

Impact Analysis

The major impact producing agents which could potentially affect coastal and marine birds as a result of the proposed action include: OCS-related oil spills; disturbance from onshore facility construction near coastal nesting areas; and displacement of birds from feeding and nesting areas due to increased aircraft and vessel traffic.

Many of the coastal and marine bird species in the CPA, which are susceptible to oil spills, are migratory and could be exposed to oil spills during their over-wintering period (October-March). Oiling of birds causes death from hypothermia, shock, or drowning; oil ingestion significantly reduces reproduction in some birds; and oil contamination of eggs by oil-fouled adult birds reduces hatchability. Indirect effects of oil pollution on birds include contamination, displacement, and reduction of food sources. Long-term contamination of food sources and habitats may cause chronic toxicity to birds through the accumulation of hydrocarbon residues and may affect their behavior, physiology, and reproduction.

Numerous species of coastal and marine birds feed and nest all along the Central Gulf coastline (Clapp et al., 1982 and Portnoy, 1977). The coastline of Terrebonne Parish has the highest chance (9%) of being contacted with an oil spill. The majority of the coastal and marine bird nesting occurs inshore and is unlikely to be impacted by coastal oil spills. The majority of the coastal and marine bird feeding habitat is nearshore (or inshore) and could be contacted by oil spills. As only one large (greater than 1,000 bbls) spill is estimated to occur and contact bird habitat in the CPA, a low level of impact is expected to coastal and marine birds in the CPA as a result of the proposed action.

Disturbance of coastal and marine bird nesting and feeding habitat from onshore construction and associated noise from aircraft, boat, and vessel traffic could result in a reduction or desertion of birds that use the habitat for feeding and nesting. Dredging and the construction of pipelines and roads could change hydrology that may result in complete conversion of a marsh ecosystem (Section IV.D.1.a.(1)).

It is estimated that over the 18- to 20-year period of this proposed action about 8,900 OCS oil/gas-related vessel trips will occur. This is about 3% of the annual vessel traffic in the CPA. The majority of this vessel traffic occurs in/out of existing port areas and probably will not have a significant impact on coastal and marine birds. If the new service base estimated for coastal area C-4 is not located in an existing port area, the increased vessel traffic could disturb feeding/nesting birds, depending on its location.

It is estimated that three pipelines and about 60 miles of onshore pipeline could be emplaced in coastal areas C-1, C-2, and C-3, and one service base may be located in C-4 (Table IV-1). If the pipelines or service base are located in undeveloped areas, there is a possibility some feeding/nesting habitat of coastal and marine birds could be disturbed or destroyed, which could result in the loss of birds in the local area.

Conclusion

In the Central Gulf, the proposed action is estimated to have a low level of impact on coastal and marine birds from offshore-related oil spills, disturbance from onshore construction, and other OCS-related oil/gas activities.

Cumulative Impacts

In addition to the impacts discussed previously for the proposed action, impacts from existing Federal OCS oil/gas leases and activities; future OCS leasing; existing oil/gas leases and activities in State tidelands; tankering of imported crude oil and petroleum products; and other commercial, military, and recreational offshore and coastal activities should be considered as cumulative impacts.

In the CPA the estimated cumulative number of oil spills resulting from the proposed action, existing OCS leases, and future leasing is 16. The estimated cumulative number of oil spills from transporting crude oil imports Gulfwide is 24. Plaquemines Parish, Louisiana, is the area with the highest probability of oil spill contact due to the extensive oil development in the Mississippi Delta area and the tankering of imported crude oil and petroleum products on the Mississippi River. An unknown number of spills could occur from oil production in Louisiana tidelands. Coastal and marine birds that migrate through more than one OCS planning area may be exposed to oil spills in other areas. The cumulative impact on coastal and marine birds from oil spills in the CPA is expected to be moderate.

Disturbance from aircraft and vessel traffic in the vicinity of bird feeding and nesting habitat in the CPA is not likely to increase above current levels as a result of OCS-related oil/gas activities. About 97% of the aircraft and vessel traffic in the CPA is non-OCS-related.

Cumulative impacts will moderately increase as a result of OCS-related onshore construction of about 10 service bases, 14 pipelines, 1 pipeline installation base, 1 pipeline coating yard, 280 miles of onshore pipeline, 1 platform fabrication yard, and 4 gas processing plants (Table IV-35).

Impacts that are not related to offshore oil/gas activities, which are difficult to quantify, but contribute to a cumulative impact to coastal and marine birds would include the loss of habitat to commercial, military, recreational, and residential construction. Dredging and draining of wetland areas along migratory flyways and in coastal feeding and overwintering areas causes additional habitat loss. Entanglement in commercial and recreational fishing gear and coastal storms and hurricanes cause flooding and destruction of nesting areas resulting in coastal and marine bird loss. High levels of oil and organic chemical contamination in the river runoff into the northern Gulf of Mexico could cause direct mortality or cause indirect food loss to avian species. Collision with power lines and supporting towers causes additional bird mortality (Avery et al., 1980).

Conclusion

The cumulative impact on coastal and marine birds in the Central Gulf is estimated to be moderate.

(7) Impacts on the Commercial Fishing Industry

The major impact producing factors on fishing activities from the proposed action would be production platforms, oil spills, and gear conflicts. Production platforms remove from 3-5 acres of trawling space, and gear conflicts result in such losses as trawls, shrimp catch, business downtime, and vessel damage. The financial losses from gear conflicts are theoretically covered by the Fishermen's Contingency Fund. All of the 230 claims (averaging about $4,000) submitted for payment for damages on the OCS Gulfwide before November 1, 1982, when the new regulations were published, have been settled. In 1983, 117 claims (averaging about $3,300) were filed and processed with 73% being approved. During FY 84, 183 claims were processed and 111 were approved for a total of $418,000. Seventy percent of these claims were from Louisiana offshore fishermen. The average claim processing time has been reduced from as much as seven months to about 40 days after NMFS receives the completed claim. Although this fund is effective, fishermen filing claims, as well as those that do not bother to do this, are absorbing some economic loss from this impact producing factor.

Oil spills that contact the coastal marshes, bays, and estuaries have the greatest potential for damage to commercial fishery resources. The majority of the Gulf's fishes are estuarine dependent. Potentially, oil spills could seriously impact fishery resources such as shrimp and many species of finfish that use these areas as nursery and/or spawning grounds, as well as sessile organisms such as oysters. Although adult finfish are usually able to avoid an offshore oil spill, large numbers of floating eggs, larvae, and juveniles could be destroyed. For more information concerning oil spill effects on fishery resources, refer to Section IV.B.6.c.

Commercial fishery resources could also be adversely affected by the discharge of drilling muds. Drilling muds contain materials toxic to marine fishes; however, only at concentrations four or five orders of magnitude higher than those found more than a few meters from the discharge point. Further, dilution is extremely rapid in offshore waters to the extent that every substance measured in the water column is at background at a distance of 2,000 m (probably within 1,000 m) of the discharge point (Ecomar, Inc., 1980). The emplacement/construction of pipelines, pipeline canals, navigation channels, and landside support facilities may contribute to changes in salinity regimes, water current patterns, turbidity, and/or wetland/seagrass loss which in turn will have a negative impact on fishery resources.

The following assumptions were used in the analysis of major impacts on the commercial fishing industry:

- The loss of fishing area from platform/structure construction will result in a very low impact if the number of acres lost represents less than 0.1% of the trawling area. The trawling area includes Federal waters (Planning Areas) extending offshore to approximately the 400 m isobath.

- It is not possible to determine the number of platforms that will be constructed in State waters; consequently, this factor is not included in the cumulative impact analysis.

- Bays refer to nearshore, open-water bays and sounds and provide finfish and shellfish nursery and/or spawning grounds.

- Open bays are considered "exposed"; that is, spilled oil from OCS activities cannot be deflected or diverted before reaching fishery resources in these areas.

- Enclosed bays are considered "unexposed"; that is, spilled oil from OCS activities can be deflected or diverted before reaching fishery resources in these areas.

- An oil spill greater than 1,000 bbls that contacts the open bays within 10 days of the spill could have severe, medium-term (1-3 years in duration) consequences on invertebrate and vertebrate fisheries and deter fishing in these areas, resulting in a high impact.

- An offshore oil spill greater than 1,000 bbls that does not contact the bays could destroy some fish eggs, larvae, and juveniles and could disrupt fishing (such as reef fishing and shrimping) if the spill occurs in close proximity to the localized fishing area. The duration of the impact will be short-term (less than one year in duration), resulting in a moderate impact.
- Fishermen will absorb some economic loss through gear conflicts since some of them will not bother to file a claim against the Fishermen's Contingency Fund, and others will be unable to establish that damage or loss was associated with energy-related activities.
- Oil spills of less than 1,000 bbls that originate on the OCS and contact State waters could result in localized short-term effects on fisheries resources with recovery probably taking place within one year, resulting in a low impact. (Cumulatively over the long-term, these spills may impact these resources; however, there is presently no evidence that small spills have had any more than minimal cumulative impacts on fisheries resources over the long history of oil and gas development and production in the Gulf.)

In addition, the following criteria for five levels of impact were developed for use in the analysis and conclusions:

Very High - An economic loss of greater than 5% to the commercial fishing industry, many fishermen out of work, and secondary employment (processing plants, etc.) substantially affected.

High - A 1%-5% economic loss to the commercial fishing industry, some fishermen out of work, and secondary employment affected.

Moderate - A 0.1%-1% economic loss to the commercial fishing industry, some financial loss to fishermen, and secondary employment affected.

Low - A 0.01%-0.1% economic loss to the commercial fishing industry, some fishermen affected, but no effect on secondary employment.

Very Low - A 0.01% or less economic loss to the commercial fishing industry, and a few fishermen affected.

Impact Analysis

Seven, thirteen, ten, and four offshore platforms/structures are expected to result from the proposed action in subplanning areas C-1, C-2, C-3, and C-4, respectively, eliminating less than 0.1% (21-35 acres in C-1, 39-65 acres in C-2, 30-50 acres in C-3, and 12-20 acres in C-4) of the trawling area in each subplanning area (Table IV-31). The total trawling area lost, 102-170 acres, would still represent less than 0.1% of the trawling area in the CPA. This loss of trawling area would result in a very low impact.

There is a 27% chance of one large spill (1,000 bbls or greater) and a 99+% chance of several smaller spills (< 1,000 bbls) occurring. The percent chance of the one large spill contacting open bays containing finfish and shellfish nursery and/or spawning grounds within subanalysis areas C-1, C-2, C-3, and C-4 is 7, 12, 7, and 0, respectively (Table IV-31). The percent distribution of open bays in the Central Analysis Area is as follows: 12% in C-1; 34% in C-2; 36% in C-3; and 19% in C-4. The greatest impact to commercial fisheries would occur in subanalysis areas C-2 and C-3 due to the high percentage of bays and the higher percent chance of spill contact. The affected areas would be Atchafalaya Bay, Timbalier Bay, Barataria Bay, and the Lake Borgne/Breton/Chandeleur Sounds. However, the probabilities of a spill contacting these areas is very low. A large spill contact with open bays could destroy fish eggs, larvae, and juveniles, and could disrupt commercial fishing in offshore areas. The result could be severe medium-term (1-3 years) effects on fisheries. However, the percent chance of one large spill

Table IV-31

Commercial Fisheries Resources and Impact Producing Factors
Central Gulf of Mexico

		Resources						Impact Producing Factors						
								Probability of One or More Large Spill Contacts[1]				Offshore Production Platforms (number)		
Subarea*	County/Parish/Land Segment	Annual Landings (million lbs)	Annual Landings (million $)	Trawling Area (million acres)	Open Bay (acres)	Sound (acres)	M Scenario	Aggregate[2]	Low Scenario	High Scenario	M Scenario	Cumulative	Low Scenario	High Scenario
C-1		568.0	77.7	7.0	189,054		9	90	4	17	7	60	3	14
	Cameron/12				-		2	59	1	4				
	Vermilion (Vermilion Bay)/13				71,048		4	58	2	8				
	Iberia (Vermilion Bay/Atchafalaya Bay)/14				118,006		3	44	1	6				
C-2		378.1	95.5	6.4	542,293		12	98	5	20	13	104	5	25
	St. Mary (Atchafalaya Bay/Timbalier Bay)/15				254,317		n	5	n	1				
	Terrebonne (Atchafalaya Bay/Timbalier Bay)/16				146,972		9	83	4	16				
	Lafourche (Barataria Bay)/17				74,192		2	75	1	3				
	Jefferson (Barataria Bay)/18				66,812		1	45	n	1				
C-3		422.3	85.8	4.6	585,522	924,070	7	95	3	14	10	82	4	19
	Plaquemines (Barataria Bay)/19				238,730	329,028	5	89	2	10				
	St. Bernard (Lake Borgne/ Breton/Chandeleur Sounds)/20[3]		346,792	595,042	2	55	1	4						
	Orleans/20				-		2	55	1	4				
	St. Tammany/20				-		2	55	1	4				
C-4		117.9	22.1	1.0	302,692	394,673	n	32	n	1	4	27	1	8
	Hancock/21[4]				1,340	37,134	n	20	n	1				
	Harrison (Mississippi Sound)/21				-	185,458	n	20	n	1				
	Jackson/21				17,555	122,138	n	20	n	1				
	Mobile (Mobile Bay)/22				134,933	49,943	n	12	n	n				
	Baldwin (Mobile Bay)/23				148,864	-	n	4	n	n				
Total				19.0			27	99+	12	44	34	273	13	66

n = value less than 0.5%
*See Figure IV-1

[1] Probability (expressed as percent chance) of one or more large (≥1,000 bbls) oil spills occurring and contacting the indicated land segments within 10 days.
[2] Related to the proposed action, prior sales, future sales in the 5-year OCS lease schedule, and imports of crude oil.
[3] Probabilities for St. Bernard Parish include those for Orleans and St. Tammany Parishes which are included in the same land segment (20).
[4] Probabilities for Hancock County include those for Harrison and Jackson Counties which are included in the same land segment (21).

occurring is low, 27%. The expected level of impact would be moderate. Finally, if the smaller spills contact open bays they could cause localized short-term effects with recovery likely to occur within one year.

Conclusion

The level of expected impact on the commercial fishing industry is estimated to be moderate.

Cumulative Impacts

In addition to the impacts discussed for the proposed action, impacts from existing Federal OCS oil/gas leases and activities (Table IV-6); existing State tidelands oil/gas leases and activities (Section IV.A.2.b.); tankering of petroleum products and foreign crude oil; other vessel traffic and port congestion; and other commercial, military, and recreational offshore activities (Section IV.A.2.c.) should be considered as cumulative impacts on the commercial fishing industry.

In addition to the 34 platforms projected for the Central Gulf from the proposed action, an additional 239 are expected to result from previous lease sales. The total area lost to trawling (717-1,195 acres) would still represent less than 0.1% of the total trawling area in the CPA. There are 2,800 existing platforms in the Central Gulf. The total area lost to trawling under existing conditions (8,400-14,000 acres) would still represent less than 0.1% of the total trawling area in the CPA This loss of trawling area would result in a very low impact.

The probability of one or more large spill (1,000 bbls) occurrences and contacts is 99+%. The probabilities of contact with open bays containing finfish and shellfish nursery and/or spawning grounds are high for subanalysis areas C-1, C-2, and C-3 (Table IV-31). The areas having the greatest potential for contact (> 50% probability) are Vermilion Bay, Atchafalaya Bay, Timbalier Bay, Barataria Bay, and Lake Borgne/Breton/Chandeleur Sounds. A spill contacting these areas could result in severe medium-term (1-3 years in duration) consequences on invertebrate and vertebrate fisheries and could deter fishing. In addition, the probability of a number of smaller spill occurrences and contacts with open bays is very high, 99+%. These spill contacts are expected to result in localized short-term effects on commercial fisheries.

Commercial fisheries in the Gulf of Mexico are also impacted by activities and events other than the oil and gas industry. Competition between large numbers of commercial fishermen, between commercial operations employing different fishing methods and between commercial and recreational fishermen for a given fishery resource, may reduce standing populations. Fishing techniques which may take significant numbers of other species as by-catch, such as trawling or gill netting, may reduce the standing populations of these as well as the desired species. Within parts of the Central Gulf, no size or count limits are imposed during certain shrimp seasons, causing overfishing in these areas. Also, shrimpers taking large numbers of fishes in the groundfish complex (croakers being an example of this group) may be contributing to reductions in the numbers of these species. Space use conflicts can result from different forms of commercial operations and between commercial and recreational fisheries. In the Central Gulf, for example, crab trapping and shrimping operations often occur in the same area, resulting in loss of fishing area to one or the other or in gear conflicts when both operations attempt to use the same space. Also, the loss of wetlands are being closely studied to determine in what way and to what extent this loss affects commercial fisheries.

Other cumulative impacts include hurricanes. During 1985, the State of Alabama suffered a total loss of $48,099,343 to the oyster industry from Hurricane Elena, which included a 90% loss of oyster resources. Alabama's application to NMFS for fishery disaster funds included a request for $1,492,088 to replant the three most productive reefs that sustained heavy damage (Cedar Point, Buoy, and Kings Bayou). The estimated recovery time for these oyster reefs was two years assuming no impacts from future hurricanes. Other Hurricane Elena fishery losses include $30,000 in plant damage and crab traps and $427,650 in damaged plants and vessels for Baldwin and Mobile Counties, respectively. In Mississippi, the estimated cost of all shore facility, vessel, and related industry damage from Hurricane Elena was $2,386,500 (USDC, NMFS, 1985b).

Hurricane Juan struck the Louisiana coast during the peak white shrimp landing period. A preliminary report of the Louisiana Department of Wildlife and Fisheries indicates that the shrimp population was dispersed throughout bay systems in some areas and that low salinities in other bays caused premature immigration offshore. In addition, scattered debris covering trawling areas resulted in damaged gear and loss of fishing time. The NMFS (1985) estimated a total cost of all shore facility, vessel, and related industry damage of $3,143,100 for Louisiana. The same damage estimate for Hurricane Danny was $125,300.

Conclusion

The proposed action, prior OCS sales, and other factors added to the widely varying baseline conditions resulting from natural environmental factors, may result in a high level of cumulative impact on the commercial fishing industry in the Central Gulf area.

(8) Impacts on Major Shorefront Recreational Beaches

Scoping effort preparatory to this EIS have identified major shorefront recreational beaches as resources of public concern potentially affected by continued OCS leasing and development. Major recreational beaches are defined as those frequently visited sandy areas along the shorefront exposed to the Gulf of Mexico which support a multiplicity of recreational activity, most of which is focused at the land and water interface. Included are National Seashores, State Park and Recreational Areas, county and local parks, urban beachfronts, and private resort areas. The general location of these beaches are reflected on Visuals Nos. 4-II and 10 and a Gulfwide listing of specific major Gulf front beaches are individually identified by county on the back of Visual No. 10.

The value of recreation and tourism in the Central and Western Gulf of Mexico coastal zone is estimated at over $8 billion annually. A significant portion of tourism expenditures are attributed to coastal counties where major shorefront beaches are primary attractions. As noted on Visual No. 14, major shorefront recreational beaches comprise an estimated 26% (140 miles) of the exposed linear coastline in the WPA but only 6% (125 miles) of the exposed linear coastline in the CPA.

The primary impacting factors most widely recognized as major threats to the enjoyment and use of recreational beaches are trash and debris and large oil spills. These are discussed in Sections IV.A.4.h. and IV.B. Other factors associated with offshore sales, such as pipeline landfalls (removal of rights-of-way across beaches during construction), offshore structure development (aesthetic implications), onshore support facility development (displacement of beach area), and lease site operational activity (noise), can directly and indirectly impact shorefront recreational beaches and associated activities. However, none of these other impacting factors are issues or major threats to the integrity or public use characteristics of major Gulffront recreational beaches of the CPA and WPA.

Widely publicized and investigated oil spill incidences such as the Santa Barbara spill of 1969, the Ixtoc spill in 1979, and the Alvenus tanker spill of 1984 have demonstrated that beaches, and recreational use of beaches, can be severely impacted from major spills. Although duplication of Ixtoc or Santa Barbara is considered remote in light of current technology and preventative mechanism in place (Sections I.B.3., 4., and 5), such incidences have occurred and may be conceivable in the future development of energy resources from the Gulf of Mexico. It is important to note, however, that even in these historical worst cases, the damages to the tourism and recreational industries were temporary (less than one year) and compensable. Recent findings from an in-depth study of the impact of the Ixtoc 1 oil spill on three south Texas shorefront beach parks indicated no significant decrease in park visitations resulting from the oil spill. The availability of gasoline, however, was shown to have a significant impact on visitation (Freeman et al., 1985).

Section IV.B. presents available information on the historic oil spills from United States operations in the Gulf, discusses the oil spill risk analysis developed for this EIS, and provides information on the extent and effectiveness of existing containment and cleanup capabilities. Most relevant to this impact analysis are the assumptions concerning the characteristics, fates, and effects of a Gulf of Mexico oil spill (Section IV.B.6.), stating that the majority of oil spills occurring in the Gulf are likely to dissipate rapidly and only a relatively small fraction is subject to tar ball formation because of the chemical properties of many northern Gulf light crudes. Tar balls are known to remain viable as long as 1-2 years in the marine environment. The analysis of major spills assumes that an originating slick remains an acute threat to shoreline recreational resources for up to 10 days after which natural processes significantly change the nature and form of the pollutant.

The following standard Gulfwide rating scale has been devised for judging the expected impact to major shorefront recreational beaches:

Very High - The overall quantity of major recreational beaches in the region will permanently change and/or a persistent change in the quality of a majority of the major beaches will be evident. Sustained regional influence on the beaches or beach-related recreational activities is expected to cause beach administrative and maintenance costs to increase significantly throughout the region. A long-term decline in regional tourism is likely to result.

High - The quality of a small percentage (those associated with at least one community) of major recreational beaches in the region will be permanently affected. Sustained influence (one or more years) on the type and intensity of beach-related recreational activities is expected to influence regional and subregional displacement of recreational use. Sustained pollution or contamination of beaches causes persistent and significant increases in beach maintenance and administrative costs on a subregional basis. A long-term decline in tourism in portions of the planning area is likely.

Moderate - The quality of a large percentage (more than one community or political subdivision) of the major recreational beach environment is minimally yet perceivably affected in a sustained manner, yet the level and type of recreational activity is not changed. Acute, short-term damage to individual beaches can occur. Beach administrative and maintenance costs will increase significantly on a short-term basis (less than one year) subregionally. Short-term effects on tourism at specific beach parks is expected.

Low - The quantity or quality of the major recreational beach environment does not change in a perceptible or sustained manner either regionally or subregionally; acute, short-term damage to individual recreational beaches is slight; the influence on one or more beach-related recreational activities is not major; and increases in beach administrative and maintenance costs are short-term and localized. Tourism implications are nil.

Very Low - The quantity and quality of major recreational beaches does not change; short-term damage to individual recreational beaches is negligible. Impacts do not preclude recreational use although they may cause minor inconveniences to local users or site administrators. Beach administrative and maintenance costs are unaffected from the base case. No effect is expected on tourism.

Impact Analysis

It is reasonable to expect that exploration and production on blocks leased in the Central Gulf of Mexico will result in some ocean litter and could lead to one major oil spill, and that spill and debris could be carried by wind, wave, and currents to interact with major shorefront recreational beaches throughout the Gulf of Mexico. As was made evident from the Alvenus tanker accident, major oil spills occurring in one region (CPA) can impact recreational resources and activities in another region (WPA).

One large spill (1,000 bbls or greater) could occur as a result of the proposed action. This spill has up to a 3% chance to contact Louisiana's major recreational beaches (Table IV-19). The Oil Spill Risk Analysis (Table IV-19) shows no risk to major recreational beaches in Mississippi, Alabama, or Texas from the proposed action (M Scenario), and only Mississippi's beaches show any risk of contact (1% probability) under the high find scenario. A number of smaller spills (less than 1,000 bbls) could also occur and contact recreational beaches. The expected impacts of such contacts are likely to cause short-term displacement of recreational activity on the areas affected; however, the quantity or quality of the recreational environment would not be changed in a sustained manner. Should major beaches such as Grand Isle State Park on the east end of Grand Isle, Louisiana, be impacted (1% probability) during the summer, some adverse social and economic impact (tourism) would be realized throughout the local community and some quick-fix remedies such as sand removal and associated disposal problems would ensue, which would impact the sand budget on the beach. Vehicles such as trucks, loaders, and graders tend to grind the oil deeper into the beach sand, causing long-term impacts to beach use.

Some litter from OCS accidents and noncompliance with OCS antipollution regulations is likely to come ashore on recreational beaches from OCS operations associated with blocks leased in Sale 110. New training and industry awareness programs focused on the beach litter problem is expected to minimize the level of indiscriminate an irresponsible trash disposal from OCS oil and gas operations. The same beaches most likely to be affected by oil spill contacts (Table IV-19) would likely be impacted by intermittent trash and debris from blocks leased in Sale 110. Incremental effects from Sale 110 on litter is unlikely to be perceptible by beach users or administrators because the OCS activity associated with blocks leased in Sale 110 will constitute only a very small percentage of the existing OCS activity in the CPA and is likely to be offset by the number of terminating leases in the next few years. Litter on recreational beaches from OCS operations will adversely affect the ambience of the beach environment, detract from the enjoyment of beach activities, and can increase administrative cost on maintained beaches.

Conclusion

The proposed action is estimated to have a low expected impact on the quantity, quality, and use of major shorefront recreational beaches in Louisiana. No impacts are estimated for major recreational beaches in Mississippi, Alabama, and Texas.

Cumulative Impacts

In addition to the impacts discussed for the proposed action, impacts from existing Federal OCS oil/gas leases and activities (Table IV-6); existing State tidelands oil/gas leases and activities (Section IV.A.2.b.); tankering of petroleum products and foreign crude oil; and debris and trash on beaches should be considered as cumulative impacts on major recreational beaches.

Up to three large (1,000 bbls or greater) and a number of smaller spills are likely to occur (89% chance) and could contact major shorefront recreational beaches in the potentially affected coastal area extending from Galveston County, Texas, to Baldwin County, Alabama, as a result of Federal and State offshore activity and crude oil import tankering. Such spill contacts could occur between 1986 and 2006 and are most likely to effect major recreational beaches in Lafourche, Vermilion, or Cameron Parishes in Louisiana. Major spill contacts are expected to result in short-term disturbances, causing temporary loss or displacement of water-related, nearshore recreational activity on specific beaches directly or indirectly impacted. Furthermore, it is important to realize, especially in the cumulative impact context, that of all chronic hydrocarbon pollution existing in the Gulf, less than 2% is directly related to Gulf of Mexico oil and gas leasing and production (Section IV.B.3.a.). Continued and expanded oil and gas operations in the CPA will contribute to the already serious problem of debris and trash on coastal beaches. This detracts from the aesthetic quality and can be hazardous to beach recreational activity and increase the cost of beach maintenance programs. Other factors such as merchant shipping, offshore commercial and recreational fishing, as well as recreational use of beaches, State oil and gas tankering, pipelines, operational discharges, condos, etc., contribute to the flotsam and jetsam currently existing on the major recreational beaches of Louisiana, Mississippi, and Alabama. Although trash and debris is a recognized problem affecting enjoyment and maintenance of recreational beaches in the CPA, very little data exist which would indicate what percentage of that litter is derived from OCS oil and gas operations. The oil and gas industry initiated in 1985 special efforts consisting of training, operational practices, and offshore workers awareness programs to minimize irresponsible offshore trash disposal associated with OCS operations. Beach erosion, a major problem in the CPA, may in some ways be exacerbated by the pervasive oil and gas developments and operations in coastal Louisiana.

Conclusion

The overall level of cumulative impact to major recreational beaches is estimated to be moderate.

(9) Impacts on Archaeological Resources

Since, in any archaeological site, the most important information is contained in the horizontal and vertical position of an artifact or archaeological feature, in relation to other cultural objects or the natural environment, any activity which disturbs that context may destroy potentially valuable archaeological data.

Considering the uniqueness of the data which may be lost as a result of a direct physical contact between an impact producing factor and an archaeological site, the following criteria of significance were developed:

Very High	- An interaction between an archaeological site and an impact producing factor occurs and results in the loss of unique archaeological information.
High	- An interaction between an archaeological site and an impact producing factor occurs and results in the loss of significant,* but not unique, archaeological information.
Moderate	- An interaction between an archaeological site and an impact producing factor occurs and results in the loss of archaeological data that are not significant.*
Low	- An interaction between an archaeological site and an impact producing factor occurs, but impacts are temporary and reversible.
Very Low	- Little damaging interaction between an impact producing factor and an archaeological site occurs.

*Significance as per National Register criteria.

(a) Historic

Impact Analysis of the Proposed Action

Of the 1,589 ships known to have sunk in the northern Gulf of Mexico between 1500 and 1945, only 110 have locations with enough accuracy to allow mapping (Table III-17). Of these 110 shipwrecks having known locations, 51 lie within the CPA.

One of these wrecks, the *El Constante*, dates from the eighteenth century, and is the only one of the 51 shipwrecks with known locations in the CPA that has been groundtruthed and evaluated for National Register eligibility. Since a complete excavation of this galleon was completed by the State of Louisiana and since the location lies within State waters, no impact to this wreck site should occur from OCS oil and gas development.

Four of the 51 ships date from the late nineteenth century, and the remainder are twentieth century (Table III-18). The probable remains of several of the twentieth century ships have been located during postlease archaeological resource surveys; however, no groundtruthing of these locations has been conducted. The historical significance of these twentieth century ships is probably low, and most would not qualify for inclusion in the National Register of Historic Places.

Although relatively precise locations are known for only 51 potentially significant shipwrecks in the Central Gulf of Mexico (Table III-18), a zone within which most of the remaining reported shipwrecks should lie (Archaeological Resources Zone 1) was defined during the archaeological resources baseline study (CEI, 1977).

Each of these shipwreck sites would have to be assessed individually through archival research and on-site evaluation to determine their uniqueness and the amount of information they might provide to our Nation's maritime heritage, although, in general, any pre-twentieth century shipwreck has a high potential for containing significant archaeological information.

Offshore development could result in an interaction between a drilling rig, platform, pipeline, or anchors and an historic shipwreck. This direct physical contact with a shipwreck site could destroy fragile ship remains, such as the hull and wooden or ceramic artifacts, and could disturb site context. The result would be the loss of archaeological data on ship construction, cargo, social organization of the vessel's crew, and the concomitant loss of information on maritime culture for the time period from which the ship dates.

Since the actual locations of 98% of the pre-twentieth century ships known to have sunk in the Gulf of Mexico are unknown (Table III-17), since the uniqueness or significance of the information they contain is presently unknown, and since the exact location of projected offshore development is unknown, the probability for an interaction between an impact producing factor and an historic shipwreck is uncertain. However, should an interaction occur, the potential exists for the loss of significant or unique archaeological information. The resulting impact would be high to very high.

Onshore historic properties include such sites, structures, and objects as historic buildings, forts, lighthouses, homesteads, cemeteries, and battlefields.

Presently unidentified onshore historic sites would have to be assessed after discovery to determine the uniqueness or importance of the data they contain. However, sites already listed on the National Register of Historic Places, and those considered eligible for the Register (Visual No. 11) have already been evaluated as being able to make a unique or significant contribution to science. Of the presently unidentified coastal historic sites which could be impacted by onshore development, some may contain unique historic information.

Onshore development as a result of the proposed action could result in direct physical contact between construction of new onshore facilities and previously unidentified historic sites. This direct physical contact with an historic site could cause physical damage to, or complete destruction of, historic sites, structures, and artifacts, and could disturb site context. The result would be the loss of information on the history of the region and the Nation. Often information contained in historical sites is unrecorded in written historical accounts. A site which contains such previously undocumented information may be the only surviving source of that information.

Under the M Scenario, the number of acres projected for disturbance from new onshore facilities in the Central Gulf is 745. Due to the low amount of acreage projected for disturbance, the visibility of most onshore historic sites, and State and Federal archaeological laws which require consideration of historic properties if any State or Federal funding or permits are required for construction, the expected impact to coastal historic sites in the CPA as a result of the projected onshore development associated with Sale 110 is very low.

Should an oil spill contact a coastal historic site such as a fort or lighthouse, the major impact would be visual due to oil contamination of the site and its environment. This impact would probably be temporary and reversible with no actual loss of information. The probability of a large spill contact (1,000 bbls or greater) is low (a 2% chance, Table IV-19). Based on the criteria of significance outlined above, the expected impact to coastal historic sites from an oil spill would be very low.

Conclusion

The expected level of impact to historic sites in the Central Gulf as a result of the proposed action is uncertain; however, the potential exists for a high to very high level of impact.

Impact Analysis of the Proposed Action with the Archaeological Resource Stipulation

The archaeological resource stipulation pertains only to impacts associated with offshore development. It serves to reduce the potential for development associated impacts to historic shipwrecks by requiring that a survey be conducted within Archaeological Zone 1 prior to lease development. This survey, by recording evidence of potential shipwrecks on and beneath the seafloor, makes avoidance or mitigation of impacts to the shipwreck possible.

Generally, in the eastern portion of the Central Gulf where unconsolidated sediments are thicker, it is more likely that shipwrecks present within a survey area would not be detected by the side scan sonar. In this area, which begins around South Marsh Island Area and extends eastward (subplanning areas C-2 and C-3), the effectiveness of the survey in detecting historic shipwrecks of composite and wooden construction would be approximately 25%-30% (Volume 1, Section II.A.1.c.(2), Table II-2 of the Final Regional EIS). In this area, the stipulation would reduce the potential for a direct physical contact between an impact producing factor and a shipwreck by 25%-30%. This would not significantly reduce the potential for an interaction; therefore, in the eastern portion of the CPA there would still be potential for a high to very high impact. In the western portion of the Central Gulf where shipwrecks are more likely to be detected by the side scan sonar, the potential for a direct physical contact between an impact producing factor and a shipwreck would be reduced by an estimated 90%. This is a sufficient reduction in probability that it can be assumed that little damaging interaction between an impact producing factor and an archaeological site would occur. Therefore, the stipulation would reduce the potential impact to historic shipwrecks in the western portion of the CPA from very high to very low.

Conclusion

In the eastern portion of the CPA, even with the adoption of the proposed stipulation, the potential impacts to historic shipwrecks could be very high. In the western portion of the CPA, the lease stipulation would reduce the potential impacts to very low.

Cumulative Impacts of the Proposed Action

Other major factors which would affect significant historic archaeological resources in the Central Gulf include trawling, sport diving/commercial treasure hunting, hurricanes, channel dredging, previous oil and gas development, and chronic, low level hydrocarbon contamination.

The most intensive areas of trawling in the Central Gulf are represented by the areas outlining the centers of abundance for white shrimp (Visual No. 4-I). Extensive trawling within these areas would probably only affect the upper 3 inches or so of sediment (NERBC, 1980). Any shipwreck site components within 3 inches of the present seabed probably would be affected should the area be trawled. On many wrecks, this zone would already be disturbed by natural factors and would contain only artifacts of low specific gravity which have lost all original context and have been heavily abraded (Muckelroy, 1978). Therefore, the effect of trawling on most historic shipwreck sites would probably be very low.

Sport diving and commercial treasure hunting are significant factors in the loss of historic data from wreck sites. While commercial treasure hunters generally impact wrecks with intrinsic monetary value, sport divers may collect souvenirs from all types of wrecks. The impact from these activities cannot be quantified.

About half of the coast along the Central Gulf was hit with 16-20 tropical cyclones between the years 1901-1955 (DeWald, 1980). The other half, between Atchafalaya Bay, Louisiana, and Texas, had a slightly lower incidence of cyclones (11-15). Seven major hurricanes also crossed the Central Gulf between the years 1954-1977. Shipwrecks in shallow waters are exposed to a greatly intensified longshore current during tropical storms (Clausen and Arnold, 1975). Under such conditions, it is highly likely that artifacts of low specific gravities (e.g., ceramics and glass) would be dispersed, leaving only the denser materials (iron, steel, ballast, and conglomerates) at the original site. Some of the original information contained in the site would be lost in this process, but a significant amount of information would also remain. Overall, a significant loss of data from historic sites has probably occurred, and will continue to occur, in the Central Gulf from the effects of tropical storms. Assuming that some of the data lost has been unique, this impact would be very high.

Because most channel dredging occurs at entrances to bays, harbors and ports, there is a high probability for impacts to historic sites because of high site densities in these areas. Assuming that some of the data lost have been unique, the impact to historic sites as a result of past channel dredging activities would be very high. In many areas, COE now requires remote sensing surveys prior to dredging to minimize such impacts.

In late 1983, there were approximately 3,600 platforms in the CPA, and about 18,000 exploration and development wells had been drilled, which is more than 4.5 times the number of exploratory and development wells estimated to result from future Federal OCS activity in the Central Gulf under the cumulative scenario. The first of these wells was drilled in 1947 prior to enactment of the legislation on which the archaeological resources surveys have been based for the past 12 years. Although information on the chronological distribution of this development is not available for this analysis, development reached its peak after the archaeological resources survey requirement began. Assuming that the archaeological resources surveys, which have been required prior to lease development over the past 12 years, have been (on an average) 60% effective in locating historic shipwrecks, the major impacts would have resulted from development prior to 1974. Although no estimate as to the potential loss can be made, due to the magnitude of this previous oil and gas activity, it is assumed that the impact from the loss of unique or significant archaeological data in the Central Gulf has been very high.

There is a 79% probability that one or more large spills (1,000 bbls or greater) and several smaller spills will occur and contact coastal archaeological sites (historic and prehistoric) under the cumulative scenario. It has been estimated that the annual input of petroleum into the Gulf from all sources approaches 2.3 million bbls. This chronic hydrocarbon contamination could have an impact on historic resources. However, since the impacts to historic sites from oil contamination are generally short-term and reversible, the expected cumulative impacts from oil contamination are estimated to be low.

Conclusion

The estimated level of cumulative impacts on the historic archaeological resource base in the Central Gulf is expected to be very high.

(b) Prehistoric

Impact Analysis of the Proposed Action

Prehistoric sites which are anticipated to occur offshore include all the types of sites observed onshore such as shell middens, campsites, kill sites, and tool manufacture areas.

As the result of an MMS-funded study (CEI, 1986), two possible prehistoric archaeological sites have been documented on the OCS. These occur in association with the ancient Sabine River valley offshore western Louisiana and eastern Texas. The results of this study demonstrate that, given the right set of geologic and environmental conditions, prehistoric sites on the OCS will have survived marine transgression and can be located and evaluated through seismic and sedimentary analyses.

Prehistoric archaeological sites on the OCS are important because the information they may provide on prehistoric human migrations, settlement patterns, subsistence strategies, and cultural contacts across now-submerged landmasses cannot be obtained from terrestrial sites. The information contained in these sites would therefore be scientifically significant, and probably unique.

Offshore development as a result of the proposed action could result in an interaction between a drilling rig, platform, pipeline or anchors, and an inundated prehistoric site. This direct physical contact with a site could destroy fragile artifacts or site features and could disturb the site context. The result would be the loss of archaeological data on prehistoric migrations, settlement patterns, subsistence strategies, and archaeological contacts for North America, Central America, South America, and the Caribbean.

Likely locations for archaeological sites cannot be delineated without high-resolution seismic data. Data of sufficient resolution are unavailable for most unleased areas of the CPA; therefore, likely site locations cannot be presently determined. Since the exact location of projected offshore development is also unknown, the probability for an interaction between an impact producing factor and a prehistoric site is uncertain. However, should an interaction occur, the potential exists for the loss of significant or unique archaeological information. The resulting impact would be high to very high.

Onshore prehistoric sites include sites, structures, and objects such as shell middens, campsites, kill sites, tool manufacture areas, ceremonial complexes, and earthworks.

Presently unidentified onshore prehistoric sites would have to be assessed after discovery to determine the uniqueness or significance of the information they contain. However, sites already listed on the National Register of Historic Places, and those considered eligible for the Register (Visual No. 11), have already been evaluated as being able to make a unique or significant contribution to science. Of the presently unidentified coastal prehistoric sites which could be impacted by onshore development, some may contain unique information.

Onshore development as a result of the proposed action could result in direct physical contact between construction of new onshore facilities and a previously unidentified prehistoric site. This direct physical contact with a prehistoric site could destroy fragile artifacts or site features and could disturb the site context. The result would be the loss of information on the prehistory of North America and the Gulf Coast Region.

Under the M Scenario, the maximum number of acres projected for disturbance from new onshore facilities in the Central Gulf is 745. Due to the low amount of acreage projected for disturbance, and State and Federal archaeological laws which require consideration of archaeological resources if any State or Federal funding or permits are required for construction, the expected impact to coastal prehistoric sites in the CPA as a result of the projected onshore development associated with Sale 110 is very low.

Should an oil spill contact a coastal prehistoric site, the potential for dating the site using Carbon-14 would be destroyed. However, if diagnostic artifacts are present in the site, loss of C-14 dating potential may not constitute a loss of unique information.

Previously unrecorded coastal sites may suffer direct physical impact from beach cleanup operations. Interaction of cleanup equipment with a site could destroy fragile artifacts or site features and could disturb the site context. The result would be the loss of information on the prehistory of North America and the Gulf Coast Region. Of the coastal prehistoric sites that may be impacted by beach cleanup operations, some may contain unique information; however, the probability of a major spill contact is low (a 27% chance, Table IV-19). Therefore, the expected impact to coastal prehistoric sites from an oil spill would be very low.

Conclusion

The expected level of potential impact to prehistoric sites in the Central Gulf as a result of the proposed action is high to very high.

Impact Analysis of the Proposed Action with the Archaeological Resource Stipulation

The archaeological stipulation pertains only to impacts associated with offshore development. It serves to reduce the potential for development associated impacts to prehistoric sites by requiring that a survey be conducted within Archaeological Zones 1 and 2 prior to lease development. This survey provides the high-resolution seismic data necessary to delineate areas having a high potential for the occurrence and preservation of prehistoric archaeological sites within a lease area. Avoidance or further investigation of potential site areas is then required.

It is estimated that the archaeological survey provided for by the lease stipulation is 90% effective in allowing identification and avoidance of high probability areas for site occurrence. This provides a sufficient reduction in the potential for an interaction between an impact producing factor and a prehistoric archaeological site, that it can be assumed that little damaging interaction would occur. Therefore, the stipulation would reduce the potential impact to prehistoric sites in the CPA from very high to very low.

Conclusion

The lease stipulation, if adopted, would reduce the potential for a very high impact to prehistoric sites in the CPA to very low.

Cumulative Impacts of the Proposed Action

Other major factors which would affect significant prehistoric archaeological resources in the Central Gulf include trawling, hurricanes, channel dredging, previous oil and gas development, and chronic, low level hydrocarbon contamination.

The most intensive areas of trawling in the Central Gulf are represented by the areas outlining the centers of abundance for white shrimp (Visual No. 4-1). Extensive trawling within these areas would probably only affect the upper 3 inches or so of sediment (NERBC, 1980). Due to the limited vertical extent of disturbance associated with trawling, it is unlikely that any prehistoric sites would be affected.

About half of the coast along the Central Gulf was hit with 16-20 tropical cyclones between the years 1901-1955 (DeWald, 1980). The other half, between Atchafalaya Bay, Louisiana, and Texas, had a slightly lower incidence of cyclones (11-15). Seven major hurricanes also crossed the Central Gulf between the years 1954-1977. These storms would affect coastal prehistoric sites on barrier islands and beach fronts by erosion and reworking of sediments which would either destroy or change the context of site components. When the number of tropical storms recorded within this century is multiplied by 30 (for sites approximately 3,000 years old), it seems highly likely that many exposed coastal prehistoric sites have been, and will continue to be, destroyed by such storms. Assuming that some of the data lost has been unique, this impact would be very high.

Because most channel dredging occurs at entrances to bays, harbors and ports, there is a high probability for impacts to prehistoric sites because of high site densities in these areas. Assuming that some of the data lost have been unique, the impact to prehistoric sites, as a result of past channel dredging activities, would be very high. In many areas, COE now requires remote sensing surveys prior to dredging to minimize such impacts.

In late 1983, there were approximately 3,600 platforms in the CPA, and about 18,000 exploration and development wells had been drilled (which is more than 4.5 times the number of exploratory and development wells estimated to result from future Federal OCS activity in the CPA under the cumulative scenario). The first of these wells was drilled in 1947 prior to enactment of the legislation on which the archaeological resources surveys have been based for the past 12 years. Although information on the chronological distribution of this development is not available for this analysis, development reached its peak after the archaeological resources survey requirement began. Assuming that the archaeological resource surveys, which have been required prior to lease development over the past 12 years, have been 90% effective in identifying areas having a high probability for the occurrence of prehistoric sites, the major impacts would have resulted from development prior to 1974. Although no estimate as to the potential loss can be made due to the magnitude of this previous oil and gas activity, it is assumed that the impact from the loss of unique archaeological data in the Central Gulf has been very high.

There is a 79% probability that one or more large spills (1,000 bbls or greater) and several smaller spills could occur and contact coastal archaeological sites (historic and prehistoric) under the cumulative scenario. In addition, it has been estimated that the annual input of petroleum into the Gulf from all sources approaches 2.3 million bbls. This chronic hydrocarbon contamination is much more significant in its potential impact on historic resources. The most serious effect of oil contamination is the alteration of the carbon content of organic materials in coastal prehistoric sites. This contamination may result in erroneous C-14 dates and the possible loss of all dating potential for a site. Thus, the loss of significant prehistoric site data may be very high.

Conclusion

The estimated level of cumulative impacts on the prehistoric archaeological resource base in the Central Gulf is expected to be very high.

b. Impacts from Alternative B - No Action

Impact Analysis

This alternative is equivalent to cancellation of a sale scheduled for a specific timeframe on an approved 5-year OCS Oil & Gas Leasing Schedule. Therefore, the opportunity is foregone or postponed for development of the estimated 0.26 billion bbls of oil and 2.15 tcf of gas in the Central Gulf, which could have resulted from this proposed sale. This could cause alteration of the energy mix at the National/regional level and could exert movement toward other energy alternatives.

Development of alternative energy supplies as replacement resources for lost domestic OCS oil and gas production include energy conservation; conventional oil and gas supplies; coal; nuclear power; oil shale; tar sands; hydroelectric power; solar and geothermal energy; and imports of oil, natural gas, and LNG.

These alternatives are examined in Appendix I.

It is difficult to predict the extent to which the development of alternative energy supplies may be necessary since other factors are involved, such as the continuing success of energy conservation by the American public, overcoming technical and economic barriers that presently exist in developing other alternative energy sources, and improving resource recovery methods to increase the rate of recovery. For more information on these alternative approaches to our Nation's energy needs, refer to the following: *Energy Alternatives: A Comparative Analysis* (Oklahoma, University of, 1975) which was prepared under contract for BLM; *Final Environmental Statements OCS Sale 58* (USDI, BLM, 1979a); *OCS Sale 70* (USDI, MMS, 1982); and Appendix I of this EIS.

The economic impacts of cancellation of a sale could be far-reaching. Increased exploration activity on recently acquired leases could partially offset a one-year delay, resulting in negligible socioeconomic impacts. A lengthy delay, however, could seriously affect the economic stability of the coastal region. The infrastructure for oil and gas production in the Gulf of Mexico is highly concentrated in the coastal areas of Louisiana and Texas. The OCS oil and gas program is a major source of employment and revenue in the area. Approximately 140,000 jobs are directly or indirectly dependent on the offshore program. The average annual payroll associated with oil and gas activities amounts to approximately $3.0 billion for the Gulf Coast region. The state and local taxes generated annually by the Federal program are approximately $239.6 million. Cancellation of a sale could reduce the amount of exploration activity, the number of exploratory wells drilled, the number of workers and facilities employed by the industry, and the payroll and tax revenues generated.

All positive and negative impacts associated with the proposed action (as discussed in Section II.A.1.) would be cancelled.

Based on the resources estimated by MMS for the M Scenario, Table IV-32 presents the energy equivalents that may be required from several alternative energy sources should this lease sale be permanently cancelled. For the purpose of clarity, this table has separately identified each potential alternative source of energy regarding substitution requirements. It is unlikely, however, that there would be a single choice between these alternative

Table IV-32

Replacement Energy Needs
Central and Western Planning Areas

	Central	Western
BTU equivalents: *(trillion BTU)		
Oil - 0.26 billion barrels	1,456.0	
- 0.13 billion barrels		728.0
Gas - 2.15 trillion cubic feet	2,195.1	
- 1.87 trillion cubic feet		1,909.3
Oil equivalents: *(billion barrels)		
Oil from other sources needed to directly replace expected oil production	0.26	0.13
Oil from other sources needed to replace expected gas production	391.9	340.9
Gas equivalents: *(trillion cubic feet)		
Gas from other sources needed to replace expected oil production	1.429	0.713
Gas from other sources needed to directly replace expected gas production	2.15	1.87
Coal equivalents: *(billion short tons)	0.152	0.110
Electrical equivalents: *(billion watts per hour)		
Substitutes for end uses**	556.4	401.9
Substitutes for input to electricity generation***	342.4	247.3

Notes. *Conversion factor used:
1 barrel of oil = 5.6×10^6 BTU.
1 cubic foot of natural gas = 1,021 BTU.
1 ton coal = 24×10^6 BTU.
1 kilowatt hour = 3,412 BTU at the theoretical conversion rate of other energy forms to electricity at 100% efficiency.

**Based on a 65% average efficiency of end use of oil and gas (such as oil and gas heating) and a plant load factor of 80%.

***Efficiency of fossil fuel electricity generation was assumed to be 40%. The plant load factor equals 80%.

sources, but instead, some combined effort to further explore and develop many or all of these forms as a substitute for OCS oil and gas production.

Conclusion

If no action is taken on this sale, all environmental impacts that could have occurred under Alternative A will be avoided. Some adverse socioeconomic impacts could include a loss of employment opportunities, payroll revenues, and tax revenues.

Cumulative Impacts

Although the impacts of the proposed action would not occur, the overall levels of cumulative impacts potentially caused by existing and future OCS leasing (excluding the proposed action) and other activities affecting the resources of concern are expected to be essentially the same as those summarized in Table S-3 and described in detail in Section IV.D.1.a.

c. Impacts from Alternative C - Delete Biologically Sensitive Offshore Habitats

This deletion alternative, as described in Section II.A.3., would delete the 67 unleased blocks of the total 177 blocks (these blocks are listed in Appendix A) which are on or near enough to biologically sensitive areas of topographic features of the CPA so that activities resulting from the proposed action could have a high probability of impacting these biota. The resource estimates for the proposed action would not be significatnly reduced as a result of adopting this alternative. Therefore, the projected number of oil spills would also remain unchanged. Such a deletion would prevent any oil and gas activity whatsoever in the affected blocks (except for pipeline construction which could be prevented through the normal pipeline permitting procedures); thus, it would eliminate any impacts to the biota of the area from oil and gas activities conducted within the blocks. Essentially, the blocks which fall within 3 nmi of the 85 m isobath of the 16 banks of the Central Gulf and 2 banks of the Western Gulf are considered to contain biota which could be harmed by oil and gas activities. Deleting this small percentage of the Central Gulf area should result in a very large reduction of the potential impacts to these high value biological resources.

The biological resources of the topographic features are considered very sensitive to potential impacts due to oil and gas operations; thus, this deletion alternative is presented in order to fully protect these resources. The proposed biological stipulation discussed in Section II.A.1.c.(1), while reducing the risks to very low (if adopted), would not remove all risk.

Topographic features in the Central Gulf are usually the surface expressions of salt domes which are often associated with oil and gas reserves. The recovery of any such reserves would be prevented by the adoption of this alternative.

In addition, there are no significant changes in the level of potential impact to historic or prehistoric archaeological resources when compared with the proposed action.

To the extent that deletion of these few blocks will reduce the oil and gas exploration and development activities of the proposed action and to the extent that the resources expected to be impacted by the proposed action (such as endangered species, commercial and recreational fisheries, water quality, etc.) are found in those blocks, the impacts to those resources will be similarly reduced.

d. Low and High Find Scenario Analyses: Proposed Action

(1) Description

Low and High Find Scenarios (L and H Scenarios)

The L and H Scenarios are analyzed to provide information on the reasonably foreseeable range of potential exploration, development, and production activities and facilities, and related impacts that might occur as a result of the proposed action. The L Scenario is based on the low resource estimates for which there is a 95% chance that more than the amount estimated is present. The H Scenario is based on the high resource estimates for which there is a 5% chance that more than the amount estimated is present. These estimates are of the conditional, unleased, undiscovered, economically recoverable resources in the area being offered by the proposed action.

The resource and offshore infrastructure estimates related to the proposed action for both scenarios are included in Table IV-33. These estimates compared to those for the M Scenario are about 60% less under the L Scenario and 80%-110% higher under the H Scenario.

The estimated timetables for offshore exploration, development and production activity are included in Table IV-34. Exploration and development activity is estimated to occur over a somewhat shorter time period under the L Scenario, while under the H Scenario a somewhat longer time period is needed compared to the M Scenario estimates. Production activity would occur over an estimated 20-year period under the L Scenario and over a 24-year period under the H Scenario.

Transportation assumptions for the L and H Scenarios are included in Table IV-33. All gas production and 80% of oil production is assumed to be pipelined to shore. The remaining 20% of oil production is assumed to be shuttle tankered to shore in Louisiana.

New onshore facility use estimates are shown in Table IV-35. The estimated number of existing new facilities, compared to the M Scenario, is somewhat lower under the L Scenario and somewhat higher under the H Scenario.

(2) Impact Analysis

The impact analyses in this subsection are written in summary format. For more complete descriptions of impact causing factors, geographical locations, and impact discussions, refer to the same subsections in Section IV.D.1.a.

(a) Impacts on Barrier Beaches/Islands

Low Find Scenario Impacts: In the CPA, onshore infrastructure development consisting of the addition of up to one pipeline landfall and 20 miles of onshore pipeline in coastal subareas C-2 and C-3 is expected to result from this scenario. The greatest potential for impact resulting from pipeline emplacement and landfall on barrier beaches would occur in coastal subarea C-2. As was the case with the proposed action (M Scenario), up to 14 acres of barrier beach habitats could be altered in C-2. This represents an alteration of less than 0.09% of this habitat type within the subarea. One oil spill (1,000 bbls or greater) and several smaller spills are assumed for analysis, and although the probability for contact is less than 5%, in the event a spill were to contact the severely eroding barrier beach network in south Louisiana, high to very high impacts could result. No ancillary facilities or new navigation canals are anticipated to result from this scenario; however, maintenance dredging of existing canals can be expected. Based on the analysis, the expected level of impact to barrier beaches is very low in subareas C-1, C-3, and C-4, and low in subarea C-2.

High Find Scenario Impacts: In the CPA, onshore infrastructure development consisting of the addition of up to 4 pipeline landfalls and up to 80 miles of onshore pipeline is expected as a result of this scenario. The greatest potential for impact resulting from pipeline emplacement and landfall on barrier beaches would occur in coastal subarea C-2. Up to two of the four landfalls are projected for this subarea; therefore, it is estimated that up to 28 acres of barrier beach habitats could be altered in subarea C-2. This represents an alteration of less than 0.19% of this habitat type within the subarea. One large spill (1,000 bbls or greater) and several smaller spill contacts are assumed for the analysis, and although the probability of a contact with barrier beach areas is less than 20%, in the event a spill were to contact these areas, high to very high impacts could result. As with the M Scenario, no ancillary facilities or new navigation canals are anticipated as a result of this scenario; however, some maintenance dredging of existing canals can be anticipated. Based on the analysis, the expected level of impact to barrier beaches is estimated to be very low in subareas C-1, C-3, and C-4, and low in subarea C-2.

(b) Impacts on Wetlands

Low Find Scenario Impacts: In the CPA, onshore construction for the low scenario is estimated to be 1 pipeline landfall and about 20 miles of onshore pipeline in either subarea C-2 or C-3. This pipeline could damage or destroy up to 168 acres of wetlands in subarea C-2 or up to 180 acres of wetlands in subarea C-3 depending on the pipeline routing. This level of impact represents less than 0.01% of the wetlands in subarea C-2 or C-3. In contrast, onshore construction for the proposed action is estimated to be three pipeline landfalls, one each in subareas C-1, C-2, and

Table IV-33

Resource and Offshore Infrastructure Assumptions:
Central Gulf Sale 110 - Low and High Find Scenarios

	L Scenario	H Scenario
Resources Expected to be Developed[1]		
Oil (billion bbls)	0.100	0.470
Gas (tcf)	0.870	4.520
Annual Peak Production[2]		
Oil (billion bbls)	0.010	0.042
Gas (tcf)	0.087	0.407
Offshore Infrastructure		
Exploration and Delineation Wells	125	620
Platforms (Production)	13	66
Development Wells	160	800
Pipeline (miles)[3]	100	400
Transportation Assumptions		
Oil - Pipelined (billion bbls/%)	0.080/80	0.376/80
Oil - Shuttle Tankered (billion bbls/%)	0.020/20	0.094/20
Gas - Pipelined (tcf/%)	0.870/100	4.520/100
Shuttle Tanker Traffic (20,000 dwt/50,000 dwt)[4]	18/7	83/33
Offshore Discharges[5]		
Drilling Mud Material (million bbls)	1.3	6.5
Drill Cuttings (million cubic yards)	0.14	0.7
Formation Waters (million bbls)	1-90	4.7-423
Offshore Air Emissions (peak year - 1,000 tons)		
NO_x	0.56	3.55
CO	0.14	0.64
SO_x	0.09	0.42
VOC	0.03	0.11
TSP	0.00	0.01
New Onshore Facilities[6]		
Service Bases (number/acres)	-	2/50
Pipeline Landfalls (number)	1	4
Pipeline (miles constructed/acres)	20/240	80/960
Gas Processing Plants	-	1/60
Service Vessel Traffic[4]	2,600	14,500
Helicopter Traffic[4]	6,100	38,700
Oil Spill Estimates: Occurrences/Probability of Occurrence/Probability of Contact[7]		
Large Spills (≥1,000 bbls)	1/22/12	2/69/43
Medium Spills (50-999 bbls)	2/73/46	7/99+/95
Small Spills (1-49 bbls)	38/99+/99+	179/99+/99+

[1] Estimates of oil and gas expected to be discovered and produced as a result of the proposed actions.

[2] Under the L Scenario, both oil and gas production occurs over the 20-year period, 1990-2009; peak oil production occurs from 1996-1998; and peak gas production occurs from 1999-2000. Under the H Scenario, both oil and gas production occurs over the 24-year period, 1988-2011; peak oil production occurs from 1994-1995; and peak gas production occurs from 1998-1999.

[3] Gathering and main pipelines.

[4] Number of trips (outbound plus inbound) for peak year activity.

[5] Total amount. Section IV.A.4.a. contains a detailed discussion on these discharges.

[6] The maximum number of new facilities expected to be established solely as a result of the proposed action, and the maximum amount of acreage expected to be used for these facilities. See Table IV-35 for location by coastal subarea.

[7] The assumed number of spill occurrences; the probability (expressed as percent chance) of one or more spills occurring; and the probability (expressed as percent chance) of one or more spills occurring and contacting land within 10 days. Spills are assumed to occur during the production periods indicated in footnote 2. The average size of a large spill is estimated at about 17 thousand bbls; the average medium spill is estimated at 154 bbls; and the average small spill is estimated at 4.2 bbls.

Table IV-34

Estimated Development Timetable for Offshore Infrastructure:
Central Gulf Sale 110 - Low and High Find Scenarios

Year	Exploration and Delineation Wells Drilled		Platforms Installed		Development Wells Drilled		Pipeline Emplaced (miles)		Oil Production (million bbls)		Gas Production (bcf)	
	Scenario		Scenario		Scenario		Scenario		Scenario		Scenario	
	L	H	L	H	L	H	L	H	L	H	L	H
1987												
1988	6	15		1		10		3		0.9		9.0
1989	17	40		2		40		6		1.4		13.6
1990	25	75	1	3	10	60	3	59	0.5	9.4	1.7	22.6
1991	33	120	1	10	10	100	3	30	1.0	18.8	7.0	45.2
1992	23	140	2	10	20	100	6	30	2.0	23.5	8.7	90.4
1993	10	90	2	10	30	100	36	30	4.0	32.9	17.4	135.6
1994	4	65	2	5	30	80	6	65	7.0	42.3	26.1	180.8
1995	3	35	2	5	20	80	6	15	9.0	42.3	43.5	226.0
1996	2	25	1	5	10	60	3	15	10.0	38.5	52.2	316.4
1997	2	10	1	5	10	50	34	15	10.0	36.7	69.6	361.6
1998		5	1	3	10	30	3	59	10.0	33.8	78.3	406.8
1999				2	10	30		6	9.0	32.0	87.0	406.8
2000				2		20		6	8.0	29.1	87.0	361.6
2001				2		20		6	7.0	27.3	78.3	339.0
2002				1		10		55	6.0	21.2	69.6	293.8
2003						10			5.0	16.5	60.9	280.2
2004									4.0	15.0	52.2	262.2
2005									3.0	13.2	43.5	203.4
2006									2.0	10.3	34.8	158.2
2007									1.8	8.5	26.1	135.6
2008									0.8	5.6	17.4	113.0
2009									0.5	4.7	8.7	67.8
2010										3.8		54.2
2011										2.3		36.2
Total	125	620	13	66	160	800	100	400	100	470	870	4,520

Source: USDI, Minerals Management Service, Gulf of Mexico OCS Region estimates.

Table IV-35

Onshore Facility Use Assumptions: Central Gulf Sale 110 - Low and High Find Scenarios

Facilities	L Scenario Existing	L Scenario New	H Scenario Existing	H Scenario New
Service Base	22	-	22	2[1]
Pipeline Installation Base	2	-	2	-
Pipe Coating Yard	5	-	9	0
Pipeline Landfall	4	1[2]	22	4[3]
Onshore Pipeline (miles)	30	20[4]	170	80[5]
Marine Terminal	1	-	2	-
Platform Fabrication Yard	2	-	6	-
Gas Processing Plant	2	-	10	1[6]
Refinery	2	-	6	-

The following notes indicate the range in the number of new facilities by coastal subarea, and likely potential locations in each subarea:

[1] 1 in C-2 and in C-3: likely potential locations are the Morgan City/Berwick/Amelia, Leeville, and Port Fourchon areas in C-2; and the Grand Isle and Venice areas in C-3.

[2] 1 in either C-2 or C-3: likely potential locations are St. Mary, Terrebonne, and Lafourche Parishes in C-2; and Jefferson, Plaquemines, and St. Bernard Parishes in C-3.

[3] 1 in C-1 and C-3, and 2 in C-2: likely potential locations are Cameron and Vermilion Parishes in C-1; St. Mary, Terrebonne, and Lafourche Parishes in C-2; and Jefferson, Plaquemines, and St. Bernard Parishes in C-3.

[4] 20 in C-2 or C-3: likely potential locations are St. Mary, Terrebonne, and Lafourche Parishes in C-2; and Jefferson, Plaquemines, and St. Bernard Parishes in C-3.

[5] 20 in C-1, 40 in C-2, and 20 in C-3: likely potential locations are Cameron and Vermilion Parishes in C-1; St. Mary, Terrebonne, and Lafourche Parishes in C-2; and Jefferson, Plaquemines, and St. Bernard Parishes in C-3.

[6] 1 in C-2; likely potential locations include St. Mary, Terrebonne, and Lafourche Parishes.

C-3; 60 miles of onshore pipeline; and one service base in subarea C-4. This onshore construction could impact up to 373 acres of wetlands. The wetlands in Terrebonne Parish, Louisiana, have the highest probability (4%) of being contacted by an oil spill under the low scenario. Terrebonne Parish has about 116 miles of coastal wetlands of which about 66% would be exposed to potential oil spills. In contrast, the probability of one or more oil spills occurring and contacting Terrebonne Parish as a result of the proposed action is 9%. Based on the analysis, the expected impact to wetlands is very low in coastal subareas C-1 and C-4, and low in coastal subareas C-2 and C-3.

High Find Scenario Impacts: In the CPA, onshore construction for the high scenario is estimated to be four pipeline landfalls, one in each subarea (C-1, C-2, C-3, and C-4); 80 miles of onshore pipeline; two service bases (C-2 or C-3 and C-4); and one gas processing plant in subarea C-2. This onshore construction could impact up to 464 acres of wetlands in the CPA, in contrast with 373 acres of wetlands for the proposed action. The maximum percentage of the wetlands affected in any one coastal subarea is 0.05% (C-2). The wetlands in Terrebonne Parish have the highest probability (16%) of being contacted by one or more oil spills under the high scenario, in contrast with 9% for the proposed action. Based on the analysis, the expected impact is low in coastal subareas C-1 and C-4, and moderate in coastal subareas C-2 and C-3.

(c) Impacts on Sensitive Offshore Habitats

Low Find Scenario Impacts

Proposed Action: Up to 125 exploration wells, 13 platforms, and 100 miles of pipelines may be expected as a result of this scenario. The biota of the topographic features and the live bottom areas would be subject to physical destruction from rig emplacement, platform and pipeline installation, and anchoring. The biota would also exhibit effects ranging from short term stress responses to mortality resulting from the discharges associated with drilling. Because the numbers of wells and platforms are less in this scenario, the possibility of an operation occurring on or near a sensitive offshore habitat would be less than for the M Scenario. However, the impacts resulting from this scenario would be as severe as from the M Scenario. The expected level of impact from the low find scenario is very high.

Proposed Action with the Biological Stipulation: Up to 125 exploration wells, 13 platforms, and 100 miles of pipelines may be expected as a result of this scenario. Imposition of the biological stipulation would prevent these operations under routine conditions from adversely impacting the topographic features and live bottoms. The biological stipulation cannot prevent impacts resulting from accidental factors such as blowouts or seafloor oil spills. Because the numbers of wells and platforms in this scenario are less than the M Scenario, the probability of an accidental impact occurring would be even less than the M Scenario. The expected level of impact from the low find scenario with the biological stipulation is very low.

High Find Scenario Impacts

Proposed Action: Up to 620 exploration wells, 66 platforms, and 400 miles of pipelines may be expected as a result of this scenario. The biota of the topographic features and the live bottom areas would be subject to physical destruction from rig emplacement, platform and pipeline installation, and anchoring. The biota would also exhibit effects ranging from short-term stress responses to mortality resulting from the discharges associated with drilling. Because the number of wells and platforms are greater in this scenario, the possibility of an operation occuring on or near a sensitive offshore habitat would be greater than for the M Scenaroio. The expected level of impact from the high find scenario is very high.

Proposed Action with the Biological Stipulation: Up to 620 exploration wells, 66 platforms, and 400 miles of pipelines may be expected as a result of this scenario. Imposition of the biological stipulation would prevent these operations under routine conditions from adversely impacting the topographic features and live bottoms. The biological stipulation cannot prevent impacts resulting from accidental factors such as blowouts or seafloor oil spills. Because the nubmers of wells and platforms in this scenario are greater than the M Scenario, the probability of an accidental impact occurring would be greater than the M Scenario. The expected level of impact from the high find scenario with the biological stipulation is very low.

(d) Impacts on Water Quality

Low Find Scenario Impacts: The discharge of up to 90 million bbls of formation waters, 1.3 million bbls of drilling muds, 145,635 yds^3 of drill cuttings, 50,000 bbls of sand from drilling operations, and an average of 54,600 gal/day of treated sanitary and domestic wastes from platforms may be expected as a result of this scenario. Pipeline-related activities would result in the disturbance of some 0.23-0.6 million yds^3 of sediment.

Offshore waters will be subject to impacts from discharges of drilling fluids, formation waters, and other effluents which add burdens of both toxic and nontoxic materials to the water column. These quantities are less than one-half of those projected for the M Scenario; however, despite the lessening of these quantities, the natural processes of dispersion, degradation, and sedimentation will result in immeasurably low concentrations of these materials within a few meters to a few kilometers of the discharge sites, resulting in low impacts.

Point source discharges from onshore support facilities and nonpoint source runoff from construction activities are estimated to be minimal with impacts to onshore water quality expected to be very low. Impacts may stem from the construction of 20 miles of onshore pipelines and one pipeline landfall in coastal subarea C-2 as projected for this region.

High Find Scenario Impacts: The discharge of up to 423 million bbls of formation waters, 6.5 million bbls of drilling muds, 725,620 yds^3 of drill cuttings, 235,000 bbls of sand from drilling operations, and an average of 275,750 Mgal/day of treated sanitary and domestic wastes from platforms may be expected as a result of this scenario. Pipeline-related activities would result in the disturbance of some 0.92-2.4 million yds^3 of sediment.

Offshore waters will be subject to impacts from discharges of drilling fluids, formation waters, and other effluents which add burdens of both toxic and nontoxic materials to the water column. These quantities are almost twice those projected for the M Scenario; however, the natural processes of dispersion, degradation, and sedimentation will result in immeasurably low concentrations of these materials within a few meters to a few kilometers of the discharge sites, resulting in low impacts.

Point source discharges from onshore support facilities and nonpoint source runoff from construction are estimated to be minimal with impacts to onshore water quality expected to be very low. These impacts may stem from the construction and operation of OCS onshore support facilities, particularly the one new gas processing plant, 80 miles of onshore pipelines, 4 new pipeline landfalls, and 2 new service bases projected for the CPA.

(e) Impacts on Air Quality

Low Find Scenario Impacts: Estimates for the CPA include no new gas processing plants and no new or expanded refineries needed. Under the M Scenario, no new refineries and four gas processing plants are projected.

It is expected that 125 exploration and delineation wells, 160 development/production wells will be drilled, and 13 platforms will be added. This compares to 320 exploratory and delineation wells, 408 development wells, and 34 platforms estimated under the M Scenario. New activity is expected to be unevenly distributed throughout the CPA.

Low impacts are expected in St. Bernard, Plaquemines, St. Mary, Lafourche, St. Charles, Jefferson, Orleans, and St. John the Baptist Parishes in Louisiana and Mobile County, Alabama. Very low impacts are expected throughout the remainder of the coastal area of the CPA and in Escambia County in the Eastern Gulf.

High Find Scenario Impacts: Estimates for the CPA include possibly one new gas processing plant and no new or expanded refineries needed. Under the M Scenario, no new refineires and gas processing plants are projected. The location of the new gas processing plant is expected in coastal subarea C-2.

It is expected that 620 exploration and delineation wells and 800 development/production wells will be drilled, and 66 platforms will be utilized. New activity is expected to be unevenly distributed throughout the CPA. The overall impact on coastal air quality is expected to be moderate in the coastal areas of Mississippi/Alabama if an uncontrolled sour gas blowout occurs nearshore.

Low impacts are expected in St. Bernard, Plaquemines, St. Mary, Lafourche, St. Charles, Jefferson, Orleans, and St. John the Baptist Parishes in Louisiana and Mobile County in Alabama. Very low impacts are expected throughout the remainder of the coastal area of the CPA and in Escambia County in the Eastern Gulf.

(f) Impacts on Endangered and Threatened Species

The impact analyses in this subsection are written in summary format. For a more complete description of impact causing factors, geographical locations, and impact discussion, refer to the same subsection in Section IV.D.1.a.

Low Find Scenario Impacts

Brown Pelicans: Analysis indicates a negligible probability (2%) of one or more oil spills (greater than 1,000 bbls) occurring and contacting brown pelican nesting habitat along the Central Gulf coast. It is unlikely that potential oil spills related to the low scenario would have an adverse impact on brown pelicans. In contrast, for the proposed action, the probability of one or more oil spills occurring and contacting brown pelican feeding/nesting habitat in Lafourche and St. Bernard Parishes in Louisiana or Hancock, Mississippi, or Mobile, Alabama, is 5%.

In the CPA, onshore construction for the low scenario is estimated to be one pipeline landfall and about 20 miles of onshore pipeline in either subarea C-2 or C-3 (Table IV-35). If the pipeline is emplaced in Lafourche (C-2) or St. Bernard (C-3) Parishes during the spring/summer brown pelican nesting period, there could be a disturbance to the pelicans in these parishes. It is estimated that onshore construction during the rest of the year or in other coastal areas would not cause a significant impact on brown pelicans. In contrast, onshore construction for the proposed action is estimated to be three pipeline landfalls, one each in subareas C-1, C-2, and C-3; 60 miles of onshore pipeline; and one service base in subarea C-4 (Table IV-1).

Aircraft and vessel traffic in the vicinity of pelican nesting areas is estimated not to increase under the low scenario. In contrast, aircraft and vessel traffic near brown pelican feeding/nesting habitat may increase about 2% in subarea C-4 under the proposed action.

A very low level of impact on brown pelicans and their feeding and nesting habitat is expected in the Central Gulf as a result of the low scenario and very low as a result of the proposed action.

Marine Mammals (Whales): There is less than a 5% probability of an oil spill occurring and contacting marine mammals (whale) in the CPA. With the low possibility of oil spill contacts in this area, it is unlikely that offshore-related oil spills resulting from the low scenario will affect whales in the CPA. In contrast, there is less than a 10% probability of an oil spill occurring and contacting whales as a result of the proposed action.

Vessel traffic in the CPA is estimated not to increase. In contrast, under the proposed action, vessel traffic in the CPA could increase in subarea C-4 about 2%. The level of OCS-related vessel collisions with whales in the CPA is unknown; no injuries or mortalities have been reported.

About 125 exploration and delineation wells may be drilled, and seismic exploration may be required over the 18- to 20-year period of the low scenario. In contrast, under the proposed action, 320 wells may be drilled and additional seismic activity may be required. Well drilling and seismic activities apparently do not pose a significant impact to whales (Gales, 1982 and USDI, MMS 1983e). No adverse impacts resulting from these activities have been reported or documented in the Gulf of Mexico region.

It is expected that OCS-related oil spills, collisions with offshore support vessels, and disturbance from OCS oil/gas activities will have a very low level of impact on whales in the Central Gulf as a result of the low scenario and very low as a result of the proposed action.

Sea Turtles: Analysis indicates a negligible probability (1%) of one or more oil spills (greater than 1,000 bbls) occurring and contacting a sea turtle nesting beach along the Central Gulf coast. With only a few turtle nesting beaches in the CPA and a very low possibility of an oil spill contact, it is unlikely that potential oil spills related to the low scenario would have an adverse impact on sea turtle nesting. OCS-related oil spills occurring and drifting offshore could result in deleterious effects on sea turtles. For the proposed action, the oil spill probability is about 2%.

OCS-related vessel traffic in the CPA is estimated not to increase. In contrast, under the proposed action, vessel traffic in subarea C-4 could increase about 2%. The level of OCS-related vessel collisions with marine turtles in the CPA is unknown; however, no adverse impacts have been reported or documented. No projected pipeline construction that would impact sea turtle nesting beaches (in subareas C-3 or C-4) is expected for the CPA coastal area as a result of the low scenario.

A very low level of impact on sea turtles and their habitat is expected in the CPA as a result of the low scenario, and a low level of impact is estimated for the proposed action.

High Find Scenario Impacts

Brown Pelicans: There is a low probability (16%) of one or more oil spills (greater than 1,000 bbls) occurring and contacting brown pelican nesting habitat in Terrebonne Parish as a result of the high scenario. It is unlikely that a spill would impact onshore pelican nesting habitat, but there is a low chance of oil contacting pelicans as they plunge-dive for fish in coastal waters. In contrast, for the proposed action, there is a 9% probability of an oil spill occurring and contacting pelican habitat in Terrebonne or St. Bernard Parishes.

Aircraft and vessel traffic in the vicinity of pelican nesting areas is estimated to increase less than 5%. Under the proposed action, aircraft and vessel traffic is estimated to increase about 2% in subarea C-4.

Four pipelines, 80 miles of onshore pipeline, two service bases, and one gas processing plant may be required in the CPA (Table IV-35). One or more of these onshore facilities could be located in Lafourche, Plaquemines, or St. Bernard Parishes, which could impact brown pelican nesting and/or feeding habitat. In contrast, onshore construction for the proposed action is estimated at three pipelines, one each in subareas C-1, C-2, and C-3; 60 miles of onshore pipeline; and one service base in subarea C-4 (Table IV-1).

A low level of impact on brown pelicans and their feeding and nesting habitat is expected in the CPA as a result of the high scenario. In contrast, a very low level of impact is estimated for the proosed action.

Marine Mammals (Whales): There is a moderate probability (less than 15%) of an oil spill occurring in the CPA and contacting whales as a result of the high scenario. In contrast, there is less than a 10% probability of an oil spill occurring and contacting whales as a result of the proposed action. As the majority of OCS oil/gas development occurs on the continental shelf and as whales usually inhabit deepwater areas off the shelf, it is unlikely that the low number of expected spills (one) will contact the low numbers of marine mammals (whales) in the CPA. It is unlikely that OCS-related oil spills resulting from this scenario will affect whales in the Central Gulf.

Vessel traffic in the CPA is estimated to increase less than 5% for the high scenario and about 2% in subarea C-4 for the proposed action. The level of OCS-related vessel collisions with marine mammals in the CPA is unknown; no injuries or mortalities have been reported.

About 620 exploration and delineation wells may be drilled, and additional seismic exploration may be required. In contrast, about 320 wells are estimated for the proposed action. Well drilling and seismic activities apparently do not pose a significant impact to marine mammals (Gales, 1982 and USDI, MMS, 1983e). No adverse impacts resulting from these activities have been reported or documented in the Gulf of Mexico region. Any disturbance is usually short-term and fairly localized, and it is unlikely to cause a major impact on marine mammals in the CPA (NMFS Biological Opinion, Appendix C).

It is expected that OCS-related oil spills, collision with offshore support vessels, and noise disturbance from OCS oil/gas activities will have a very low level of impact on marine mammals and their habitat in the Central Gulf as a result of the high scenario and a very low level of impact for the proposed action.

Sea Turtles: There is about a 4% probability of one or more spills (greater than 1,000 bbls) occurring and contacting a sea turtle nesting beach in the Chandeleur, Horn, or Ship Islands as a result of the high scenario, and about the same probability for the proposed action. With only a few turtle nesting beaches in the CPA and a very low possibility of an oil spill contacting a nesting beach, it is unlikely that potential oil spills related to the high scenario would have an adverse impact on sea turtle nesting. OCS-related oil spills occurring and drifting offshore could result in deleterious effects on sea turtles.

Offshore-related vessel traffic in the CPA is estimated to increase less than 5% as a result of the high scenario and 2% in subarea C-4 as a result of the proposed action. The incidence of OCS-related vessel collisions with sea turtles in the CPA is unknown; however, no adverse impacts have been reported or documented.

Four pipeline landfalls, 80 miles of onshore pipeline, 2 service bases, and 1 gas processing plant may be required in the CPA as a result of the high scenario. Somewhat less onshore construction is estimted for the proposed action (Table IV-1). It is unlikely that any of this onshore construction will occur near a sea turtle nesting beach in the CPA.

A moderate level of impact on sea turtles and their habitat is estimated in the CPA as a result of the high scenario, and a low level of impact is estimated for the proposed action.

(g) Impacts on Coastal and Marine Birds

Low Find Scenario Impacts: There is a low probability (about 4%) of one or more oil spills (greater than 1,000 bbls) occurring and contacting feeding/nesting habitat of coastal/marine birds in the CPA as a result of the low scenario and about 9% for the proposed action. Considering the low probability oil spills in this area, it is unlikely that OCS-related oil spills resulting from this scenario will affect coastal and marine birds feeding areas in the CPA.

Disturbance of coastal and marine bird nesting and feeding habitat from onshore construction and associated noise from aircraft, boat, and vessel traffic could result in a reduction or elimination of birds that use the habitat for feeding and nesting. Dredging and the construction of pipelines and roads could change hydrology that may result in complete conversion of a marsh ecosystem.

One pipeline landfall and about 20 miles of onshore pipeline is estimated for the low scenario. It is unlikely this pipeline will be located near coastal/marine bird nesting habitat, and the construction phase is expected to have a very low impact on coastal/marine birds in the CPA. In contrast, three pipeline landfalls, about 60 miles of onshore pipeline, and one service base is estimated for the proposed action.

A very low level of impact on coastal and marine birds and their feeding and nesting habitat is expected in the Central Gulf as a result of the low scenario, and a low level of impact is estimated for the proposed action.

High Find Scenario Impacts: Terrebonne Parish, Louisiana, has the highest probability (16%) of one or more oil spills occurring and contacting coastal and marine bird habitat. Considering the probability of oil spills resulting from the high scenario, it is likely that OCS-related oil spills could contact coastal and marine birds feeding areas in this coastal area. For the proposed action, Terrebonne Parish, Louisiana, has the highest probability (9%) of oil spill contact.

Disturbance of coastal and marine bird nesting and feeding habitat from onshore construction and associated noise from aircraft, boat, and vessel traffic could result in a reduction or elimination of birds that use the habitat for feeding and nesting. Dredging and the construction of pipelines and roads could change hydrology that may result in complete conversion of a marsh ecosystem.

Two service bases, 1 gas processing plant, 4 pipelines, and about 80 miles of onshore pipeline may be required in the CPA. This onshore construction could impact coastal and marine bird nesting and/or feeding habitat. As discussed above, the onshore construction estimated for the proposed action is less than the estimate for the high scenario.

A low level of impact on coastal and marine birds and their feeding and nesting habitat is expected in the Central Gulf as a result of the high scenario and also for the proposed action.

(h) Impacts on the Commercial Fishing Industry

Low Find Scenario Impacts: Thirteen offshore platforms/structures are expected in the CPA, eliminating less than 0.1% (39-65 acres) of trawling area. Of these 13 offshore platforms/structures, 3 are expected for subplanning area C-1, 5 for C-2, 4 for C-3, and 1 for C-4. Fishermen would absorb some economic loss through gear conflicts. The probability of one or more large spill (1,000 bbls) occurrences and contacts is 12%. The probabilities of these spills contacting open bays containing finfish and shellfish nursery and/or spawning grounds are very low (< 6%, Table IV-31). A very low impact is expected on the commercial fishing industry.

High Find Scenario Impacts: Sixty-six offshore platforms/structures are expected in the CPA, eliminating less than 0.1% (198-330 acres) of trawling area. Of these 66 offshore platforms/structures, 14 are expected for subplanning area C-1, 25 for C-2, 19 for C-3, and 8 for C-4. The probability of one or more large spill (1,000 bbls) occurrences and contacts with open bays containing finfish and shellfish nursery and/or spawning grounds are high for subanalysis areas C-1, C-2, and C-3 (Table IV-31). The areas having the greatest potential for contact are Barataria Bay, Atchafalaya Bay, and Timbalier Bay. Spill contacting these areas could result in severe medium-term (1-3 years in duration) consequences on invertebrate and vertebrate fisheries and could deter fishing. A high impact is expected on the commercial fishing industry.

(i) Impacts on Major Shorefront Recreational Beaches

Low Find Scenario Impacts: No major spills are likely to occur (1% chance) and contact recreational beaches; therefore, there would be no adverse impact to shorefront recreational beaches under the scenario, except from occasional wash-up of trash and debris from OCS operations. Under the low find scenario, a total of 285 wells are expected to be drilled over a 12-year period resulting in the installation of 13 offshore production platforms and production of 100 million bbls of oil (Table IV-34). Under the most likely find scenario, 492 wells will be drilled, 23 production platforms installed, and 260 million bbls of oil produced. The low find scenario will lead to approximately one-half the offshore activity and oil production associated with the most likely find scenario;

therefore, the potential for oil spills and trash loss should be about one-half that of the most likely find scenario resulting from the proposed action.

High Find Scenario Impacts: There is up to a 5% chance that one major spill will occur and contact a major recreational beach along the coast of Louisiana under the high find scenario for proposed Sale 110. Mississippi's major beaches show a 11% probability of contact, and Alabama, Texas, and Florida recreational beaches show no risk of contact (Table IV-19). Together with trash and debris problems associated with sale specific operations, impact to major recreational beaches throughout the CPA and WPA is expected to be low; however, should a specific beach be contacted by a major spill, that beach would suffer major, short-term (2-6 weeks) recreational impact. Under the high find scenario, a total of 1,420 wells are expected to be drilled over a 15-year period (1987-2002) resulting in the installation of 66 new offshore production platforms and production of 470 million bbls of oil (Table IV-34). Under the most likely find scenario, 492 wells will be drilled, 23 production platforms installed, and 260 million bbls of oil will be produced. The high find scenario will lead to approximately three times the offshore activity and two times the oil production associated with the most likely find scenario; therefore, the potential for oil spills should about double and the trash loss triple that of the most likely find scenario resulting from the proposed action.

(j) Impacts on Archaeological Resources

Low Find Scenario Impacts

Historic: The lower level of offshore development projected for the low find scenario would reduce the potential for an interaction between an impact producing factor and an historic shipwreck. Should an interaction occur, the potential exists for the loss of significant or unique archaeological information. The resulting impact would be high to very high.

The archaeological stipulation, if adopted, would reduce the potential for an interaction between an impact producing factor and an historic shipwreck by 25%-30% in the eastern portion of the CPA. This would not significantly reduce the potential for an interaction; therefore, in the eastern portion of the CPA, there would still be potential for a high to very high impact. In the western portion of the CPA, the potential for an interaction would be reduced by 90%. This is a sufficient reduction in probability and it can be assumed that little damaging interaction between an impact producing factor and an archaeological site would occur. Therefore, the stipulation would reduce the potential impact to historic shipwrecks in the western portion of the CPA from very high to very low.

Under the low find scenario the number of acres projected for disturbance from new onshore facilities in the CPA is 240 acres. Due to the low amount of acreage projected for disturbance, the visibility of most onshore historic sites, and State and Federal archaeological laws which require consideration of historic properties if any State or Federal funding or permits are required for construction, the expected impact to coastal historic sites in the CPA as a result of the projected onshore development associated with the low find scenario is very low.

Should an oil spill contact a coastal historic site such as a fort or lighthouse, the major impact would be visual due to oil contamination of the site and its environment. This impact would probably be temporary and reversible with no actual loss of information. Under the low find scenario the probability of a large spill contact (1,000 bbls or greater) is low (a 1% chance, Table IV-19). Based on the criteria of significance outlined above, the expected impact to coastal historic sites from an oil spill would be very low.

Prehistoric: The lower level of offshore development projected for the low find scenario would reduce the potential for an interaction between an impact producing factor and a prehistoric site. Should an interaction occur, the potential exists for the loss of significant or unique archaeological information. The resulting impact would be high to very high.

The archaeological stipulation, if adopted, would reduce the potential for an interaction between an impact producing factor and a prehistoric archaeological site by about 90%. This is a sufficient reduction in probability that it can be assumed that little damaging interaction between an impact producing factor and an archaeological site would occur. Therefore, the stipulation would reduce the potential impact to prehistoric sites in the CPA from very high to very low.

Under the low find scenario the number of acres projected for disturbance from new onshore facilities in the CPA is 240 acres. Due to the low amount of acreage projected for disturbance, and State and Federal archaeological laws which require consideration of archaeological properties if any State or Federal funding or permits are required for construction, the expected impact to coastal prehistoric sites in the CPA as a result of the projected onshore development associated with the low find scenario is very low.

Should an oil spill contact a coastal prehistoric site, the potential for dating the site using Carbon-14 would be destroyed. However, if diagnostic artifacts are present in the site, loss of C-14 dating potential may not constitute a loss of unique information.

Previously unrecorded coastal sites may suffer direct physical impact from beach cleanup operations. Interaction of cleanup equipment with a site could destroy fragile artifacts or site information on the prehistory of North America and the Gulf Coast Region. Of the coastal prehistoric sites that may be impacted by beach cleanup operations, some may contain unique information; however, the probability of a major spill contact is low (a 1% chance, Table IV-19). Therefore, the expected impact to coastal prehistoric sites from an oil spill contact would be very low.

High Find Scenario Impacts

Historic: The higher level of offshore development projected for the high find scenario would increase the potential for an interaction between an impact producing factor and an historic shipwreck. Should an interaction occur, the potential exists for the loss of significant or unique archaeological information. The resulting impact would be high to very high.

The archaeological stipulation, if adopted, would reduce the potential for an interaction between an impact producing factor and an historic shipwreck by 25%-30% in the eastern portion of the CPA. This would not significantly reduce the potential for an interaction; therefore, in the eastern portion of the CPA, there would still be potential for a high to very high impact. In the western portion of the CPA, the potential for an interaction would be reduced by 90%. This is a sufficient reduction in probability that it can be assumed that little damaging interaction between an impact producing factor and an archaeological site would occur. Therefore, the stipulation would reduce the potential impact to historic shipwrecks in the western portion of the CPA from very high to very low.

Under the high find scenario the number of acres projected for disturbance from new onshore facilities in the CPA is 1,070 acres. Due to the low amount of acreage projected for disturbance, the visibility of most onshore historic sites, and State and Federal archaeological laws which require consideration of historic properties if any State or Federal funding or permits are required for construction, the expected impact to coastal historic sites in the CPA as a result of the projected onshore development associated with the high find scenario is very low.

Should an oil spill contact a coastal historic site such as a fort or lighthouse, the major impact would be visual due to oil contamination of the site and its environment. This impact would probably be temporary and reversible with no actual loss of information. Under the high find scenario the probability of a large spill (1,000 bbls or greater) is low (a 3% chance, Table IV-19). Based on the criteria of significance outlined above, the expected impact to coastal historic sites from an oil spill would be very low.

Prehistoric: The higher level of offshore development projected for the high find scenario would increase the potential for an interaction between an impact producing factor and a prehistoric site. Should an interaction occur, the potential exists for the loss of significant or unique archaeological information. The resulting impact would be high to very high.

The archaeological stipulation, if adopted, would reduce the potential for an interaction between an impact producing factor and a prehistoric archaeological site by about 90%. This is a sufficient reduction in probability that it can be assumed that little damaging interaction between an impact producing factor and an archaeological site would occur. Therefore, the stipulation would reduce the potential impact to prehistoric sites in the CPA from very high to very low.

Under the high find scenario the number of acres projected for disturbance from new onshore facilities in the CPA is 1,070 acres. Due to the low amount of acreage projected for disturbance, and State and Federal archaeological laws which require consideration of archaeological properties if any State or Federal funding or permits are required for construction, the expected impact to coastal prehistoric sites in the CPA as a result of the projected onshore development associated with the high find scenario is very low.

Should an oil spill contact a coastal prehistoric site, the potential for dating the site using Carbon-14 would be destroyed. However, if diagnostic artifacts are present in the site, loss of C-14 dating potential may not constitute a loss of unique information.

Previously unrecorded coastal sites may suffer direct physical impact from beach cleanup operations. Interaction of cleanup equipment with a site could destroy fragile artifacts or site features and could disturb the site context. The result would be the loss of information on the prehistory of North America and the Gulf Coast Region. Of the coastal prehistoric sites that may be impacted by beach cleanup operations, some may contain unique information; however, the probability of a major spill contact is low (a 3% chance, Table IV-19). Therefore, the expected impact to coastal prehistoric sites from an oil spill would be very low.

e. Unavoidable Adverse Impacts of the Proposed Action

Wetlands: There is a chance that one or more spills greater than 1,000 bbls could occur and contact land within 10 days over the production life of the proposed action. If an oil spill does contact coastal wetlands, adverse environmental impacts could be high. The adverse effects of oil on coastal wetlands would be relatively long-term (1-3 years).

Construction of new pipelines/infrastructure is expected to damage or destroy up to 72 acres of wetlands in subarea C-1, 168 acres in subarea C-2, up to 180 acres in subarea C-3, and up to 25 acres in subarea C-4. Up to six acres of seagrasses could be damaged or destroyed in either subarea C-2 or C-3 from pipeline emplacements.

Sensitive Offshore Habitats: Severe and perhaps permanent damage to the biota of topographic features would result if a blowout or seafloor oil spill were to occur in proximity to a topographic feature. In addition, the proposed action, without the biological stipulation, would result in potentially permanent destruction of the productive biological habitats of the topographic features and live bottom areas.

Water Quality: Normal offshore operations would have unavoidable effects to varying degrees on the quality of the surrounding water if the proposal is implemented. Drilling, construction, and pipelaying would cause an increase in the turbidity of the affected waters for the duration of the activity periods, and, in the case of pipelines, could disturb settled pollutants. A turbidity plume, several hundred yards in length, could also be created by discharge of drill cuttings and the adherent drilling fluids. This, however, would only affect water in the immediate vicinity of the rigs. The discharge of treated sewage from the rigs and platforms would increase the levels of suspended solids, nutrients, chlorine, and BOD in a small area near the discharge points. Chronic spills from platforms and the discharge of formation waters will result in increases of hydrocarbon levels and possibly trace metal concentrations in the water column. Overall, the effect will be the degradation of water quality around platforms, although the extent of the impact will extend only from a few meters to a few tens of meters from the platform site.

Unavoidable impacts to onshore water quality will also occur as a result of runoff from construction sites of new facilities, but these impacts will be localized in the vicinity of these sites, and of limited duration. Some additional impacts will accrue from increased sewage due to population growth in certain communities. Regulatory requirements of the State water authorities (under Federal and State regulations and guidelines) and some local jurisdictions would be applicable to most, if not all, of these potential impact situations. Therefore, the opportunity would exist to effectively mitigate potential impacts if applicable regulatory measures were strictly enforced.

Air Quality: Unavoidable adverse impacts to air quality would occur onshore adjacent to crude oil refineries, gas processing plants and areas of concentrated OCS activities. Unavoidable short-term impacts to air quality would occur near catastrophic events (oil spills, blowouts with fire, blowouts without fire) due to evaporation and combustion. Mitigation of long-term effects will be accomplished through existing regulations. However, short-term effects from nonroutine catastrophic events (accidents) are uncontrollable.

Endangered and Threatened Species: OCS-related oil/gas vessel traffic in the Central Gulf could result in some collision injuries to marine turtles. Oil spills could result in some injury or mortality to marine turtles and brown pelicans. Some injury to endangered whales could result from OCS-related oil spills and/or collision with offshore support vessels and/or seismic activities.

Coastal and Marine Birds: Some injury or mortality to individual and/or local populations of coastal and marine birds could result from OCS-related oil spills.

Commercial Fishing Industry: Of the various types of fishing gear in use in the OCS areas, trawls have the greatest chance for operational conflicts with oil and gas activities. Losses may, however, be compensated under the Fishermen's Contingency Fund or other legal routes. Trawl nets can be snagged on underwater stubs causing damage or loss of the nets. In addition, it is conceivable that snags could damage underwater production equipment or pipelines causing a spill of oil and gas. Because safety equipment is installed, which shuts in production when a loss of pressure occurs, the likelihood of a major spill resulting thereby is considered very small. Less frequently, large objects which were lost overboard from petroleum industry boats, pipeline lay barges, and platforms are caught by fishing gear resulting in damage to the gear and/or its catch of fish; however, occurrence of this type of incident is low. Also, commercial fishermen would probably not harvest fish in the area of an oil spill, as spilled oil could coat or contaminate commercial fish species rendering them unmarketable. Other unavoidable adverse impacts include loss of fish space caused by installation of unburied pipelines, rigs, platforms, or by other OCS-related structures. There may be some localized competition for shore facilities.

Major Shorefront Recreational Beaches: Even though existing regulations and orders prohibit indiscriminate littering of the marine environment with trash, offshore oil and gas operations involving men, machines, equipment, and supplies is bound to result in some littering of the ocean. Human nature and accidents associated with offshore operations will contribute some floatable debris to the ocean environment which will eventually come ashore on major recreational beaches. Likewise, accidents can lead to oil spills which are difficult to contain in the ocean; therefore, it may be unavoidable that some recreational beaches become temporarily soiled by weathered crude oil.

Archaeological Resources: As a result of the proposed action, unique or significant archaeological information may be lost. The lease stipulation would significantly lower the potential for this loss occurring by identifying potential archaeological sites prior to interaction occurring, thereby making avoidance or mitigation of impacts possible.

Military Use/Warning Areas: In this planning area, the trips of helicopters and service boats, and the location and number of exploration rigs and production structures will produce unavoidable adverse impacts on military use of the warning areas to the extent that military missions could be curtailed or shifted to another location within a warning area, in particular, within Warning Area 155.

Continued cooperation between industry, the USAF, and the Navy should prevent the loss of life and equipment when industry helicopters and service vessel traffic cross an intensively used warning area. Continued flexibility in operations by the USAF and Navy should help to maintain a joint usage of the warning areas.

Ports and Marine Transportation: A certain amount of interference between offshore structures and vessel traffic will occur as a result of the proposed actions. This could lead to an increase in accidents involving OCS vessels and structures. Most foreign flag vessels and others who may be unaware of the locations of structures in an area will generally use the extensive network of safety fairways, which provides clear passage 2 nmi in width through the developed areas of the Gulf (Section I.B.4.a.). Those more familiar with an area may choose not to use the fairways. Coast Guard regulations regarding structure safety lights and horns, and ship safety regulations are important factors in minimizing conflicts and preventing accidents between structures and vessels on the OCS. However, at night, in rough water and in fog, the potential for all accidents increases.

f. Irreversible and Irretrievable Commitment of Resources

Wetlands: An irreversible and irretrievable commitment of biological resources could occur where wetlands are impacted by frequent oil spills and chronic low level contamination with oil. Repeated contact with oil will destroy wetlands vegetation which results in soil erosion and land loss. Animals killed by oil spills constitute a permanent loss of coastal biota.

Construction and emplacement of infrastructure and pipelines in wetlands can result in the permanent loss of coastal wetlands due to mechanical destruction of plants and animals and due to land loss facilitated by saltwater intrusion followed by erosion of marsh soils.

Sensitive Offshore Habitats: An irreversible and irretrievable commitment of biotic resources would occur in areas subjected to intensive development. Oil spills and chronic low level pollution can injure and kill organisms at virtually all trophic levels. Mortality of individual organisms can be expected to occur, and possibly reduction or even elimination of a few small or isolated populations. Section IV.D.1.a.(2) identifies the types of impacts which can occur and the resources which are particularly sensitive to adverse impacts resulting from the proposed actions. Adverse impacts resulting from the proposed action, without the biological stipulation, are expected to be very high and potentially permanent.

Archaeological Resources: Although the expected impact to archaeological resources as a result of the proposed action is uncertain, any interaction between an impact producing factor (drilling of exploratory, delineation, and development wells, placement of platforms, subsea completions, and pipeline installation) and a significant historic shipwreck or prehistoric site would destroy information contained in the site components and in their spatial distribution. This would be an irretrievable commitment of potentially unique archaeological data.

Local Employment, Income, and Population: The proposals would result in the production of certain OCS-related goods and services. To the extent that resources would be drawn away from other uses, production of goods and services in other areas of other types would be foregone. Steel products, specialized manpower, and capital constitute required resources which may be scarce; use of these resources for OCS needs means that other opportunities for their use might have to be foregone. While these resources may be reclaimed over time, their use as a result of the proposals would constitute an irreversible and irretrievable commitment of resources at a given point in time. To the extent that underemployed labor resources are used to fill new job opportunities, this would not constitute a cost to society in the form of foregone labor opportunities.

Oil and Gas Development: Leasing of the proposed blocks and subsequent development and extraction would represent an irreversible and irretrievable commitment of nonrenewable oil and gas resources. The estimated amount of resources recovered as a result of Sale 110 is 0.26 billion bbls of oil and 2.15 tcf of gas.

Loss of Human and Animal Life: OCS oil and gas exploration, development, production, and transportation is carried out under comprehensive, state-of-the-art, enforced regulatory procedures designed to ensure public safety and environmental protection. Notwithstanding, some loss of human and animal life is inevitable from unpredictable and unexpected acts of man and nature (adverse weather conditions, unavoidable accidents, human error, and noncompliance). Some normal and required operations such as platform removal will result in the destruction of viable marine communities. Although individual organisms and fish will die, there is unlikely to be a lasting effect on baseline marine populations.

g. Relationship Between the Short-term Use of Man's Environment and the Maintenance and Enhancement of Long-term Productivity

The principal short-term use of the leased areas in the Gulf under the proposed actions would be for the production of an estimated 0.26 billion bbls of oil and an estimated 2.15 tcf of natural gas.

This activity would temporarily interfere with recreation and tourism in the region in the event of a major oil spill (1,000 bbls or more) contacting popular tourist beaches. The probability of such an occurrence within a 10-day period after a spill is 3%.

The short-term recovery of hydrocarbons may have long-term impacts on offshore biologically sensitive areas (Section IV.D.1.a.(2)) or archaeological resources (Section IV.D.1.a.(9)).

The proposed leasing may also result in onshore development and population increases which may cause very short-term adverse impacts to local community infrastructure, particularly in areas of low population and minimal existing industrial infrastructure. However, these impacts will occur only in the very short run. A return to equilibrium can be quickly expected as population changes and industrial development are absorbed in expanded communities.

After the completion of oil and gas production, oil spills and their impacts will not occur, and the marine environment is generally expected to remain at or return to its normal long-term productivity levels. It has been recognized that continuous, low-level pollution from toxic chemicals, including oil, may adversely affect long-term ocean productivity. However, to date there has been no discernible decrease in long-term marine productivity in OCS areas where oil and gas have been produced for many years. Areas such as the Atlantic coast, which experienced repeated incidents of oil pollution as a result of tanker groundings during World War II, show no apparent long-term productivity losses, although baseline data do not exist to verify this. In other areas which have experienced apparent increases in oil pollution, such as the North Sea, some long-term effects appear to have taken place. Populations of pelagic birds have decreased markedly in the North Sea in recent years--prior to the beginning of North Sea oil production. Until more reliable data become available, the long-term effects of the chronic and major spillage of hydrocarbons and other drilling related discharges cannot be accurately projected. In the absence of such data, it must be concluded that the possibility of decreased long-term productivity exists as a result of the proposed actions. It is possible that such high value areas as the Flower Garden Banks will suffer long-term losses as a result of these proposed actions.

OCS development off Louisiana and Texas has supported recreational and commercial fishing activities. This has stimulated the manufacture and sale of larger private fishing vessels and special fishing and recreational equipment. Additionally, commercial enterprises such as charter boats have become heavily dependent on offshore structures for satisfying recreational customers. These proposed sales will increase these incidental benefits of offshore development. The platforms expected to result from the proposed actions will help replace those currently being removed where production has terminated. As the incidence of offshore fishing and diving has gradually increased in the past three decades, platforms (the focus of much of that activity) will eventually begin to gradually decline as mineral resources become depleted. In order to maintain the long-term productivity of site-specific, artificial locations attractive to fishermen and divers, some means, such as proliferation of artificial reef development programs, will need to eventually replace platform removals.

In summary, short-term environmental socioeconomic impacts may result from the proposed leasing schedule, including possible short-term losses in productivity as a result of oil spills. Long-term adverse environmental impacts are not expected if the archaeological and biological stipulations are adopted as part of the proposed action. However, some risk remains due to the potential for accidents. Oil and gas reserves would be lowered. Few long-term productivity or environmental gains are expected as a result of this proposed action; the benefits of the leasing schedule are expected to be principally those associated with a medium-term increase in supplies of domestic oil and gas. While no reliable data exist to indicate long-term productivity losses as a result of OCS development, such losses are possible.

2. Western Gulf Sale 112

a. Impacts from Alternative A - The Proposed Action

(1) Impacts on Sensitive Coastal Habitats

(a) Barrier Beaches/Islands

The nature of impacts on barrier beaches/islands will be the same as those discussed for the Central Gulf (Section IV.D.1.a.(1)(a)).

Impact Analysis

As a result of the anticipated leasing activities associated with proposed lease Sale 112, up to two pipeline landfalls are estimated for the Western Gulf. The greatest potential for impact resulting from pipeline emplacement and landfall on barrier beaches would occur in coastal subareas W-1 and W-2. In coastal subarea W-1 (San Patrico and Calhoun Counties) up to one oil/gas transmission pipeline is estimated, whereas, in coastal subarea W-2 (Jefferson and Matagorda Counties) 1-2 pipelines are estimated. Based on two possible routing scenarios for W-1, a pipeline from the Federal OCS could cross Mustang Island in San Patricio County and terminate in the vicinity of Ingleside, Texas, in the same county, or cut across Matagorda Island in Calhoun County and terminate near Sea Drift, Texas, in the same county. In both scenarios a maximum of 18.4 acres of barrier beach habitat could be altered as a result of construction activities. This represents an alteration of 0.01% of these habitat types within coastal subarea W-1.

Based on the routing scenarios for W-2, it is anticipated that a pipeline crossing the Matagorda Peninsula in Matagorda County and terminating in the vicinity of Wadsworth, Texas, in the same county would create the greatest amount of impact to the barrier beach systems in this coastal subarea. This scenario could alter up to 23 acres of barrier beach habitat, which represents an alteration of 0.07% of these habitat types within coastal subarea W-2.

As indicated in Section IV.D.1.a.(1)(a) for the Central Gulf, the construction trench through the beach would result in short-term, localized changes; however, that portion of the trench that is cut through the dune ridge could create a major zone of environmental disturbance. This area is a zone of potential instability and in the landform/vegetation complex that often is difficult to restore. Adverse impacts to this area could be ameliorated through the implementation of rigid construction practices and proper scheduling, the employment of mitigating measures, and the restoration of the dune system. Construction through the dune complex could result in the future breaching of the entire system and adversely affecting those areas protected by the dunes. Breaching of any barrier beach/island would occur at weak or sensitive points (disturbed, non-vegetated, or low areas), therefore, the location at which a pipeline is constructed through an altered beach-dune complex could become a point for breaching during a severe storm. The potential exists for storms to expose pipelines by subjecting them to extreme tidal and scouring action.

Reconstruction activities consist of refilling the pipeline trench using original material and removing sheet piling, where used. The beach is graded to return the area to its original contours. Although the aesthetic recovery of the beach is relatively quick, the beach may be vulnerable to wave attack and erosion until natural resorting restores the beach sediments back to equilibrium. After refilling the trench, the dune is restored to its original elevation and replanted with vegetation similar to that of the surrounding dunes. Where seasonal conditions do not permit immediate replanting, netting, thatching, or sand fencing may be used as anti-erosion devices until replanting can commence. The primary concern with the dune restoration phase is to insure its return to the natural protective function of sheltering the backshore wetlands or other environments from direct attack from storm waves and salt water inundation. Temporary roads and paths are removed and natural drainage patterns are usually restored to the extent possible.

No ancillary facilities are anticipated for construction in association with the proposed action. These facilities generally occupy 30-60 acres of land and may be located at 40 to 200 mile intervals along gas transmission lines. The exact location, or the need for one will be dependent on the gas' formation pressure at the well, the distance from the OCS gathering system to the onshore connection, adequate land availability, and local zoning ordinances.

Most of the counties along the Texas coastline contain barrier beach systems which are exposed and highly vulnerable to contact from potential oil spills resulting from the proposed action. One large spill (1,000 bbls or greater) is assumed for analysis purposes and although the probability for a contact is less than 10% for every county analyzed, in the event a spill were to contact the barrier beach network in Texas, high to very high impacts could result. Clean-up activities could result in the removal of large volumes of beach sands from the beach front and dune areas. Aside from the fact that sand would be removed from the area, it is assumed that heavy equipment would be needed for clean-up activities of this nature, thereby, altering beach and dune habitat areas adjacent to the contact site and rendering a beach inaccessible for recreational uses. Due to the natural occurrence of an extensive network of washover areas in the south Texas barrier areas, in the event a spill were to occur during high water or storm conditions, the impacts could be much more extensive. This may include damaging habitats that exist on the backshore areas, most of which consist of salt marsh habitats or transporting the spilled oil directly into the bays and estuaries adjacent to these landforms. See also Section IV.D.1.a.(8) for a discussion of Impacts on Major Shorefront Recreational Beaches.

The long term behavior of barrier beaches, islands, etc. depends principally on the rate of sea level rise, sand supply, sea energy, and human intervention. Sand supply is often the key to a barriers evolution, and with a constant supply of this material, they can maintain themselves in place. It was estimated that the amount of sand material removed during the *Alvenus* spill was comparable to the quantity removed for an equal segment of beachfront during a storm. Although this area exhibits a greater sand/sediment supply than the Louisiana area, as is the case in Louisiana, the major coastal rivers and nearshore currents no longer deliver the volumes of sediment they once did. This natural decrease has been aggravated to varying degrees by man's intervention.

No new navigation canals are expected to result from the proposed action. However, maintenance dredging of existing navigation canals occurs periodically and this in itself interferes with dynamics (littoral system) of such a complex, endangering the natural deposition of sand/sediment and the self maintenance of its features.

Conclusion

As a result of the proposed action, the level of expected impact on barrier beaches/islands is estimated to be very low in coastal subarea W-1 and low in coastal subarea W-2. The overall level of impacts to the WCA will be low.

Cumulative Impacts

Increased oil/gas exploration and production activities in the Western Gulf will contribute to the cumulative impacts on barrier beaches within this region. These activities, along with current and future activities in association with State tidelands' oil and gas operations, construction and development within the coastal zone, beach protection and stabilization projects, recreational-use pressures, and natural events are among the contributions to the overall cumulative impacts on barrier beach/island systems. For a discussion on other factors considered to cumulatively impact barrier beaches/islands, see Section IV.D.1.a.(1)(a).

An unknown number of additional structures may be constructed as a result of resource development in State-owned coastal waters. The construction of several additional pipelines from existing lease blocks in both Federal and State waters may occur in the future as a result of increased development activities in these areas. Pipeline-related activities resulting from prior OCS sales could result in the alteration of barrier habitats from the addition of up to 10 new pipeline landfalls (W-1 (5) and W-2 (5)) and up to 200 miles of onshore pipeline as a result of the proposed action, and future and prior OCS sales in the WPA. Twenty-three large oil spills (1,000 bbls or greater) and numerous smaller spills resulting from Federal OCS and import tankering activities are assumed for analysis purposes. Land segments with the high probabilities of contact include Galveston/Chambers County (57%) in the WPA and Cameron Parish (50%) in the CPA. The Galveston/Chambers County segment has the greatest potential for receiving high to very high impacts to barrier beaches in the event a spill were to contact this area as a result of the proposed action.

With land loss rates in coastal Texas exceeding 400 acres/yr (Morton, 1977), preservation of the Western Gulf's barriers and shorelines has become of increasing concern, as is the case in Louisiana. In this century land losses along the Texas shoreline have amounted to more than 10,000 acres, with erosion rates averaging 7-8 m/yr. These barriers serve to protect the State's vast interior wetlands from direct attack from storm waves and salt water intrusion.

The three primary causes of coastal barrier erosion and land loss include: (1) reductions in sediment supply; (2) relative sea-level rise; and (3) human activities; although listed separately the third category directly affects the other two. Of foremost importance is the natural decrease in sediment supply that accompanied climatic changes over the past few thousand years. The major coastal rivers and nearshore currents are no longer delivering the volume of sediment that they once did. This natural decrease in sediment supply has been aggravated to varying degrees by dam construction and entraining of rivers, and emplacement of jetties, groins, and seawalls that compartmentalize the coast and disrupt the longshore transport of sand. These structures have locally contributed to shoreline erosion and their contribution to land loss may be even greater in the future (Morton, 1982).

Relative sea-level rise refers either to rising of the water level or sinking of the land surface. Both processes produce the same effect and both may act simultaneously, with the end result being that the land becomes submerged and the shoreline retreats inland. Along the Texas and Louisiana gulf coast relative sea-level rise in recent years averaged between 0.5 and 1 m per century (Hicks, 1972) and both natural processes and human activities are involved.

Serious attempts to stabilize the gulf shoreline, especially at harbor entrances, began in the mid-1800's when safe navigation into the shallow bays was becoming important to the coastal economy. Perhaps the most famous structure is the Galveston seawall that was erected to prevent overwash and flooding from storms such as the 1900 hurricane that claimed more than 6,000 lives. Rigid engineering structures have often produced poor and, in some cases, deleterious results. Large amounts of money have been spent on structures designed to save the beach, but many are ineffective and some have aggravated existing problems. Except for the Galveston seawall most concrete shoreline protection structures erected on the Gulf coast in recent years have failed or have been severely damaged by storms. These structures have finite lives, are expensive to construct and maintain, and they commonly transfer the erosion problem elsewhere by locally eliminating the sediment supply. Nonrigid techniques do not interfere greatly with natural processes, although there are some problems associated with dune stabilization (Morton, 1982).

Artificial beach nourishment is probably the most effective way to deal with beach erosion problems. Sand is supplied to the beach at the same rate that it is naturally being lost alongshore or offshore. The problem is in being able to locate nearby sources of unpolluted sand of the correct size.

Attempts to stabilize highly dynamic barrier islands will ultimately fail as sea level continues to rise. While engineering structures may be successful in localized areas for the short term, long-term problems are ultimately created, and substantial, continuing maintenance costs are incurred with this approach.

Conclusion

The overall cumulative level of impact to barrier beaches/islands is estimated to be very high in the WCA.

(b) Wetlands

A general discussion of the major impact producing factors and their potential effect on coastal wetlands is included in Section IV.D.1.a.(1)(b). Also included in that section are the estimates used in this analysis on potential wetlands loss due to pipeline and other new OCS-facilities construction, and the description of the five levels of impact used in the analysis and conclusions. In the analyses that follow, the Western coastal subareas (W-1 and W-2) are used as the basic geographic unit for estimating and describing impacts.

Impact Analysis

Those factors resulting from this proposed action which could have impacts on wetlands in the WPA are oil spills, pipeline placement, canal dredging, and construction of onshore facilities in wetland areas. Kenedy, Kleberg, Nueces, Aransas, and Calhoun Counties in Texas contain some wetlands that could be impacted by oil spills (Visual

No. 14, Final EIS 94/98/102). An oil spill coming into contact with wetlands could cause devastating and medium-term damage (1-3 years). Important variables determining the degree and impact include the amount and toxicity of the crude, the degree of weathering the crude has undergone prior to contacting a wetland, wetland type contaminated by the crude, the climate and weather of the spill site, the water depth and suspended sediment load, the cleanup method attempted, and previous exposure to oil spills. Oil spills could enter coastal estuaries through inlets between the barrier islands and contact wetland areas. Oil leaks could also occur from pipelines transporting offshore production to onshore processing facilities. If an oil leak occurred in or near a coastal estuary and contacted the intertidal wetland areas, depending on the situation existing during the spill, up to 20% of the wetland vegetation could be damaged or destroyed for a 1-3 year period.

The probability of one or more oil spills occurring and contacting wetlands in Texas range from a high of 9% in Galveston and Chambers Counties to 1% in Matagorda County, Texas. About 21 miles of non-forested wetlands would be exposed to potential offshore oil spills in Galveston County; about 31 miles in Chambers County; and about 1 mile in Matagorda County in Texas. This indicates that the probability of an oil spill contact with wetlands in Texas is low. The majority of this coastal area is protected by barrier islands, and most of the inlets could be blocked with oil booms to reduce the chance of an oil spill damaging the wetland areas. The risk of an OCS-related oil spill occurring and contacting this area is low, and it is unlikely there would be a significant oil spill impact to wetlands in this area.

In coastal subarea W-1, one service base and one pipeline are estimated. It is likely that the service base would be located in a non-wetland area. If it is located in wetlands, about 25 acres of coastal wetlands could be altered or destroyed. The potential locations for the pipeline include Seadrift (Calhoun County) or Ingleside (San Patricio County). The pipeline route to Seadrift or Ingleside could alter or destroy up to 12 acres of wetlands. Thus, the impact on coastal wetlands could be a loss of up to 37 acres of wetlands in coastal subarea W-1. This represents a loss of 0.01% of these habitats in coastal subarea W-1.

In coastal subarea W-2, one service base and one pipeline are estimated. It is likely the service base, requiring up to 25 acres, would be located in a non-wetland area. If the service facility is located in a wetland area, up to 25 acres of coastal wetlands could be altered or destroyed. The potential locations for the pipelines include Bay City (Matagorda County), Freeport (Brazoria County), and Port Arthur (Jefferson County). Should the pipeline route to Bay City cross the Matagorda Peninsula, up to 12 acres of wetlands could be altered or destroyed. Should a pipeline route to Freeport traverse wetlands from the coastline to Freeport, up to 36 acres of wetlands could be altered or destroyed. It is possible to route a pipeline to Port Arthur through natural or man-made waterways to avoid wetland impacts. However, should this pipeline be placed entirely in wetlands, up to 180 acres of wetlands could be altered or destroyed. Thus, the impact on coastal wetlands could be a loss of up to 241 acres for a loss of 0.05% of these wetland habitats in subarea W-2.

Offshore-related facilities constructed onshore must comply with pertinent Federal, State, and local regulations and permitting procedures. These regulatory procedures implement policies which seek to avoid or mitigate adverse impacts. This analysis assumes that these policies and regulatory procedures will be moderately successful in mitigating adverse effects on coastal wetlands that could occur as a result of the proposed action.

Conclusion

The level of impact on coastal wetlands is estimated to be very low in coastal subarea W-1 and low in coastal subarea W-2. The level of impact on coastal wetlands in the WCA resulting from the proposed action is estimated to be low.

Cumulative Impacts

The non-forested wetland habitat base, 875,245 acres, in the WCA is decreasing; however, no composite annual rate of decrease is available. In addition to the impacts described for the proposed action, Section IV.D.2.a.(1) and Appendix E have a further discussion of cumulative wetlands loss. Major factors affecting this loss are residential, urban, and industrial development, submergence, and wave erosion (Shew et al., 1981). Development replaces the coastal wetlands with upland habitats. Submergence increases the depth, periodicity, and in some cases duration of given levels of salinity. Wave erosion replaces the non-forrested emergent wetlands with open water.

In W-1, three service bases requiring up to 75 acres, five pipelines with 100 miles of onshore pipeline, one pipeline installation base requiring up to 5 acres, one pipeline coating yard requiring up to 60 acres, and one gas processing plant requiring up to 60 acres. About this same onshore construction (one less service base) is estimated for subarea W-2. If all of this onshore construction is located in the Western Gulf coastal areas, a maximum of 1,400 acres could be required in each subarea W-1 and W-2. This represents a potential wetlands loss of 0.3% in both subareas W-1 and W-2.

Three oil spills are estimated as a result of prior, proposed, and future offshore Federal oil/gas activities, and 24 oil spills are estimated from Gulfwide tankering of imported crude oil and petroleum products. Additional oil spills could occur from State oil/gas activities. Cumulatively, the highest probability (57%) of an oil spill occurring and contacting wetlands along the Texas coast is in Galveston County. The lowest, with a 1% probability, is in Cameron County, Texas. These oil spills are estimated to cause a moderate level of impact in coastal subareas W-1 and W-2.

Conclusion

The expected level of cumulative impact on coastal wetlands is estimated to be low in coastal subareas W-1 and W-2. The cumulative level of impact on coastal wetlands in the WCA as a result of other coastal activities unrelated to offshore oil/gas activities is estimated to be moderate.

(2) Impacts on Sensitive Offshore Habitats

(a) Topographic Features

The topographic features of the Western Gulf are offshore habitats sensitive to oil and gas activity. The potential impact producing factors on the topographic features of the Western Gulf are oil spills, blowouts, anchoring, structure emplacement, and effluent discharge.

Oil spills may occur at the surface due to tanker spillage or at the seafloor due to pipeline rupture or well blowout. Surface spills could discharge either large amounts of crude or refined oil for a short period of time. Both surface and subsurface spills could result in a steady discharge of oil over a long period of time. These types of accidents are rare in the Gulf.

Blowouts can occur from either oil or gas wells. Oil well blowouts result in oil spills as discussed above. Both gas and oil well blowouts result in large amounts of bottom sediment being thrown into the water column. These sediments fall back to the seafloor and can affect the organisms living there. Blowouts are also relatively rare accidents.

Anchoring of pipeline lay barges, drilling rigs, or work boats and structure emplacement (pipeline, drilling rig, or platform emplacement) result in physical disturbance of the benthic environment. These activities are routine operations of oil and gas exploration and development and are unavoidable.

Drilling muds and cuttings discharge results in localized water turbidity, deposition on the surrounding seafloor, and potential effects of the low concentrations of toxic constituents. Drilling discharge is also a routine operation in exploration and production activity.

The potential impact producing factors are discussed more thoroughly in Section IV.A.4.

The following definitions are used to describe the expected level of impact to the topographic features resulting from the proposed action.

Very High	A species, population, community, or assemblage will be harmed to the extent that recovery of that particular entity may not occur.
High	A significant interference with ecological relationships. This usually involves the mortality or a biological alteration of a noticeable segment of the population, community, or assemblage.
Moderate	A short-term interference with ecological relationships. Although some species may sustain substantial losses, other species will sustain low losses, and the ecological mix will not be altered.

Low - A few species may sustain low losses, but any interference with ecological relationships will not be evident.

Very Low - Loss of a few individuals but no interference with ecological relationships.

Of the topographic features listed in Table III-4, the following are located in the Western Gulf:

	Crest (m)	Surrounding Seafloor (m)	Category*	Shallowest Zone**
Shelf Edge Banks				
East Flower Garden	15	110	A	*Diploria-Montastrea-Porites*
West Flower Garden	20	120	A	*Diploria-Montastrea-Proites*
Geyer	37	200	A	*Millepora*-Sponge
Rankin	52	125	A	Algal-Sponge
Elvers	60	180	A	Algal-Sponge
MacNeil	62	90	N/A	Algal-Sponge
Phleger	122	200	N/A	Nepheloid
Midshelf Banks				
Claypile***	40	50	B	*Millepora*-Sponge
32 Fathom***	52	55	C	Antipatharian
Coffee Lump***	62	70	B	Antipatharian
Stetson	20	60	B	*Millepora*-Sponge
29 Fathom	52	72	N/A	Antipatharian
South Texas Banks				
Sebree***	15	18	N/A	Nepheloid
Big Adam***	60	64	D	Antipatharian
Small Adam***	60	66	D	Antipatharian
Big Dunn Bar***	61	67	N/A	Antipatharian
Small Dunn Bar***	63	67	N/A	Antipatharian
Blackfish***	60	72	D	Antipatharian
Mysterious***	70	80	D	Antipatharian
Baker	56	72	C	Antipatharian
Aransas	57	71	C	Antipatharian
Southern	58	80	C	Antipatharian
North Hospital	58	69	C	Antipatharian
Hospital	59	74	C	Antipatharian
South Baker	59	82	C	Antipatharian
Dream	62	80	C	Antipatharian

*A - Maximum environmental protection is recommended.
B - Environmental protection is strongly recommended.
C - Environmental protection is recommended
D - Protection is not recommended
N/A - Bank was not categorized.
(Rezak and Bright, 1981).

**Biotic zones designated by Rezak and Bright, 1981, and Rezak et al., 1983 (Section III).

***Low Relief Bank.

The topographic features of the Western Gulf are sensitive to oil and gas activities. For this reason, leases in past sales have contained a biological stipulation designed to protect these habitats from leasing activities. A stipulation is presented in Section II.B.1.c.(1) as a potential mitigative measure. An impact analysis is presented below for the proposed action and for the proposed action with the application of the biological lease stipulation.

Impact Analysis of the Proposed Action

The potential cause of adverse impacts on the topographic features resulting from oil and gas exploration and development are oil spills, blowouts, anchoring, structure emplacement, and drilling discharge as discussed above. The biological stipulation is designed to eliminate impacts to the sensitive topographic features from routine oil and gas activities.

One large oil spill, two medium spills, and a number of small spills (mostly 1-5 bbls of oil) could occur as a result of adopting this proposal. These oil spills may occur from either surface or seafloor sources. Surface spills could occur from tankers or oil platforms. Most of the small spills would occur from surface sources. The medium and large spills are equally likely to result from surface spills as seafloor spills. Oil from a surface spill can be driven into the water column. Measurable amounts have been documented at depths approximating 10 m. At this depth, the oil is only found at concentrations several orders of magnitude lower than the amount shown to have an effect on corals (Lange, 1985; McAuliffe et al., 1975 and 1981; Knap et al., 1985). In the Western Gulf, the East Flower Garden Bank crests the shallowest at 15 m. Therefore, a surface spill would likely have no impact on the biota of the East Flower Gardens or other topographic features because any oil which might be driven to 18 m or deeper would be well below the concentrations needed to effect an impact.

If the one large and two medium spills were from seafloor sources, the impacts on topographic features could be different. A seafloor spill could occur from a pipeline rupture, a leak, or from an oil well blowout. (The impacts from a blowout other than the release of oil into the water column are discussed under the impacts from blowouts below.) The biota of the topographic features of the Western Gulf could be significantly impacted by a seafloor oil spill. Oil spilled from a seafloor source may be entrained and transported for great distances in subsurface currents. This was the case for the Ixtoc-1 spill, where some oil released into the water column at the seafloor circulated in the Gulf below the surface for months before reaching the Texas coast (Section IV.B.6.b.). Such oil at depth could come in contact with the biologically sensitive topographic features (banks) of the Western Gulf. In addition, a surface spill over or very near one of the banks would have significant effects. Ten blocks in proximity to the topographic features will be expected to be leased as a result of the Western Gulf sale. From these leases, 25 exploratory wells and 2 platforms can be expected. Thus, the potential for subsurface spill in proximity to the banks exists. The effluents could impinge directly upon the edge of the bank. Impacts could then be serious to the local biota. Destruction of the biota of such areas may have severe and long-lasting deleterious consequences on the specific commercial and recreational fisheries habitats affected, such as loss of habitat, loss of species (including prey species), destruction of hard substrate, and change in sediment characteristics, all of which may result in the reduction or loss of one or more fisheries. These areas also have intrinsic biological, ecological, and aesthetic values of their own which would be lost by such activities. Corals would probably not be impacted this severely. Knap et al. (1985) found that *Diploria strigosa* dosed with oil exhibited sublethal effects which occurred rapidly. The effects were short-term and recovery of the coral was rapid. *Diplora* appears to be relatively tolerant of brief exposures to chemically dispersed crude oil. Non-chemically dispersed oil adhered longer to the substrate and would lengthen the exposure time of coral to oil, thereby increasing the impacts. Of note is the fact that the cryptic fauna associated with the coral community may be more sensitive to oil dosage than the corals.

The probability of an oil spill occurring at all is low in the Western Gulf. The probability of the spill being from a seafloor source is even lower. Even if a seafloor spill were to occur, the spill would have to come into contact with a biologically sensitive feature. The fact that the topographic features are widely dispersed in the Western Gulf, combined with the probable random nature of spill locations would serve to limit the extent of damage from any given spill to only one of the sensitive areas. The current which moves around the banks may steer any spilled oil around the banks rather than directly upon the banks. Although the potential impact to the topographic features from an oil spill would be very high, the risk of such an event occurring is very low.

Blowouts can present a serious threat (due to burying by resuspended sediments) to important biological resources if one were to occur on or near a topographic feature (Section IV.C.1.). Gas well blowouts generally pose far less environmental risk than do oil spills, resulting only in very high concentrations of suspended sediments and increased levels of gas in the water column very near the source of the blowout. The extent that oil or condensate is present in the reservoir, some liquid hydrocarbons may also be injected into the water column. The suspended sediments may be carried some distance by currents, but the bulk of the sediments are redeposited within a few thousand meters of the blowout site. Low-molecular-weight-hydrocarbons (gases) will dissolve in the water column until saturation is reached; both gaseous and dissolved low-molecular-weight hydrocarbons will be released into the atmosphere within a few days of a blowout without major biological effect. Liquid hydrocarbons will be diluted to background levels within a few thousand meters distance from the blowout site and will degrade with time. Refer to Section IV.A.4. for a discussion of impacts of documented blowouts in the Gulf of Mexico.

A blowout directly on a bank or nearby a bank could have serious long-term or permanent consequences. Twenty-five exploratory wells and two platforms can be expected near the banks in the Western Gulf. In most cases, it is expected that the currents will sweep the contaminants around the bank rather than deposit them on the bank (Rezak et al., 1983). Some small fraction of the sediments or oil may reach a bank and come in contact with organisms; the extent of damage will depend on the amount of contaminant and the length of time it remains on the bank. Amounts are not expected to be high because of dilution, dispersion, settling, and current action (sweeping the contaminant around the bank). Length of time on the bank may be long for the heavier sediments, but these are likely to settle out rapidly and not reach the bank at all (Brooks and Bernard, 1977). A large blowout occurring near a biologically sensitive area could have severe environmental and consequences. Large amounts of the sediment resuspended by the blowout could smother the coral community causing mortality. Recolonization would be slow if at all. A blowout occurring directly on top of a bank would destroy not only the biota of the feature but also the feature itself making recolonization impossible. Such an accident would replace the topographic feature with a crater. Since the biota of the banks are dependent upon topographic relief, the community which was destroyed by the blowout could not recover.

Fortunately, blowouts are quite rare in the Gulf of Mexico. In addition to the low probability of occurrence, the blowout would have to be in close proximity to a topographic feature to cause an impact. The risk to the biota of topographic features from blowouts is therefore low.

Considerable mechanical damage will be inflicted upon the bottom by normal and routine oil and gas operations. The drilling operation itself disturbs some small areas. The presence of the structure can cause scouring of the surficial sediments (Caillouet et al., 1981). Anchors from support boats and ships, floating drilling units, and pipeline laying vessels do a great deal of damage to the seafloor. The area actually affected will depend on depth of water, length of chain, size of anchor and chain, wind, and current. Anchor damage is the most serious threat to coral reefs. Anchoring in biologically sensitive areas would include crushing and breaking of coral heads. Anchoring often destroys a wide swath of sessile organisms when the anchor is dragged or the vessel swings at anchor causing the anchor chain to drag the seafloor. Anchor damage from non-lease activity has been documented at the Flower Gardens (Section IV.A.4.).

Twenty-five exploratory wells and 2 platforms can be expected within 3 miles of the 22 sensitive banks in the Western Gulf. It is unlikely that any of these activities would occur directly on top of one of the 16 banks because of the hazards involved in drilling on an uneven seafloor such as at the banks and because hydrocarbons would not be expected directly under the banks but rather at the banks' flanks. However, it is likely that with so many activities occurring in proximity to the banks that anchoring of the rigs and of rig support boats would occur at the banks. MMS can, as part of the operational plan approval process for a specific lease activity (Section I), require conditions on the operator of a lease which could protect the banks from anchoring. Without a lease stipulation, these conditions are not required to be imposed. Therefore, impacts to the topographic features from the proposed action are assumed to be very high due to anchoring.

Pipeline emplacement also causes considerable disruption to the bottom (Section IV.C.2.). It is estimated that six acres of the bottom is physically disturbed per mile of pipeline laid; some 2,300-6,000 yd^3 of sediment are resuspended per mile of pipeline, depending on the size of the pipeline and depth of trenching (burial). Add to this damage caused by the eight anchors of the pipelaying barge and it is clear that considerable damage will be done if such activities are conducted in sensitive coral areas. Pipeline emplacement is not expected directly over the uneven topographic feature; however, in bypassing the feature the pipeline can be expected to be placed within deeper portions of the sensitive zones of a bank. MMS can impose restrictions as part of the development plan or pipeline application (Section I), but is not required to do so without the lease stipulation.

The impact due to mechanical damage from routine oil and gas operations is, therefore, assumed to be very high for the banks listed above except: Phleger, Sebree, Big Adam, and Small Adam Banks. Phleger Bank crests at 122 m, deeper than the lower limit of the no activity zones (85 m or 100 m in the case of the Flower Gardens). The depth of the bank precludes the establishment of the Antipatharian Zone so that even though the banks is in clear water, the biota are typical of the nepheloid zone. This type of community is not sensitive to oil and gas activities. Sebree Bank is a low relief feature, approximately 3 m, and is subject to high sedimentation. The organisms on the feature are similar to those of the nepheloid zone. Sebree Bank attracts commercially and recreationally important finfish (Tunnell, 1981). Structure emplacement would enhance this attracting aspect. Impacts to the biota of the nepheloid zone of Sebree Bank or Phleger Bank are not expected to be significant. Big and Small Adam Banks are also low relief features subject to sedimentation. Rezak and Bright (1981) categorized these features as Class D banks, where protection is not recommended. A BLM study designed to map the bathymetry of the banks of the Gulf (Texas A&M Research Foundation, 1974) did not discern these features as mappable banks. Although designated in the table above that the banks may contain the Antipatharian Zone, this designation is speculative (Rezak et al., 1983). The biota of Big and Small Adam Banks are not expected to be significantly affected.

Twenty-five exploratory wells and 2 platforms can be expected within 3 miles of the 22 sensitive banks in the Western Gulf. These oil and gas operations will routinely discharge drilling muds and cuttings which may impact the biota of the banks due to toxic effects or turbidity and sedimentation. Most water-based fluids are nontoxic, and their effects are limited to the immediate vicinity of the discharge (NAS, 1983). The depth surrounding the sensitive topographic features ranges from 50-200 m. The water depth adds to the dilution of the drilling effluent. None of the wells or platforms are expected to be placed directly over the sensitive portions of the banks, as discussed above. Therefore, no effects to the biota of the topographic features are expected due to toxicity.

Impacts to the biota are expected, however, from the turbidity and sedimentation associated with drilling discharge. In the Gulf of Mexico OCS, about 90% of the discharge settles rapidly, usually within 1,000 m (NAS, 1983). Small amounts of drilling effluent may reach a bank from wells drilled more than 1,000 m away; however, these amounts from single wells, where measurable, would be extremely small and would have no effect on the biota. Continuous drilling of numerous wells in proximity to but greater than 1,000 m from a bank, as at a development platform, may cause an impact to the biota of a Category A or B bank due to potential continuous exposure to low levels of effluent. Category C and D banks are subjected naturally to sedimentation and would be unaffected by these low levels of drilling effluent. The impact is not expected to be high from such an activity because it is unlikely with the varying currents that a bank would be subjected to effluent throughout the life of a drilling project and because the currents at the banks would keep the bank swept clean of fine sediments and would prevent the accumulation of drilling muds at the bank. Effluents discharged within 1,000 m of a bank would impact the biota of the bank. Drilling muds and cuttings discharge causes turbidity and sedimentation. The muds and cuttings can smother the sessile benthic invertebrates causing mortality. Turbidity from the discharge can cause reduced light levels to the benthic organisms and clogging of the feeding mechanisms of the sessile invertebrates. These conditions can lead to reduced productivity, susceptibility to infection, and mortality. MMS, as a condition of the operational plan approval, can require the operator of a lease to perform certain measures, such as shunting, which would reduce the impacts to the biota of the banks to very low. USEPA, through its NPDES permitting procedures, may also require mitigative measures.

Produced water discharge is sometimes cited as a potential hazard to the biota of topographic features. Produced water is relict seawater associated with produced hydrocarbons. It contains high concentrations of inorganic salts ranging from a few milligrams per liter to 350,000 mg/l. Hydrocarbons and organic compounds may be present in parts per million levels (Offshore Operators Committee, 1975). The study of the Buccaneer oil field offshore (USDC, NMFS, 1977) reported that produced water was discharged at a rate of 138 m^3 per day between January 1975-February 1976. The average oil content of this produced water was 25.1 ppm. Near-platform macrobenthic populations were depressed and had a high turnover rate as compared to the surrounding sea bottom; this may have been a result of increased scour action around the platform structure itself, but no cause-effect relationship was established. OCS Order No. 7 requires that all discharges must meet USEPA standards which allow no more than 72 mg/l daily maximum of oil and grease discharge and 48 mg/l maximum monthly average (72 mg/l is equivalent to 72 ppm). Due to the water depth at the topographic features, the discharged produced water would be greatly diluted. Therefore, the biota of topographic features are not expected to be affected by the discharge of produced waters.

Conclusion

Activities resulting from the proposed action will have a very high impact on the biota of the topographic features.

Impact Analysis of the Proposed Action with the Biological Stipulation

The proposed action with the topographic features stipulation, would prohibit lessees from operating in an established "No Activity Zone" at each of the banks except Phleger, Sebree, Big Adam, and Small Adam Banks. The prohibition extends to all activity conducted by the lessee including the anchoring of rigs and support vessels. The low relief banks, 32 Fathom Bank, Coffee Lump, Big and Small Dunn Bar, Blackfish Ridge and Mysterious Banks, contain only the No Activity Zone. The stipulation at the low relief bank, Claypile Bank, would require a 1,000 m zone in which monitoring of the effects of the drilling discharge would be required. The remaining banks would require, in addition to the No Activity Zone, a zone extending at least 1,000 m from the bank in which shunting of the effluent to within 10 m of the seafloor is required. At the high relief midshelf and shelf edge banks, the shunt zone would extend 1 nmi from the bank and to 3 nmi from development discharge. The East and West Flower Garden Banks would require the shunt zone to extend 4 nmi from the banks.

The potential cause of adverse impacts on the topographic features resulting from oil and gas exploration and development are oil spills, blowouts, anchoring, structure emplacement, and drilling discharge as discussed above. The biological stipulation is designed to eliminate impacts to the sensitive topographic features from routine oil and gas activities.

One large oil spill, two medium spills, and a number of small spills (mostly 1-5 bbls of oil) are assumed in the Western Gulf in this analysis. These oil spills may occur from either surface or seafloor sources. Surface spills could occur from tankers or oil platforms. Most of the small spills would occur from surface sources. The medium and large spills are equally likely to result from surface spills as seafloor spills. Oil from a surface spill can be driven into the water column. Measurable amounts have been documented at depths approximating 10 m. At this depth, the oil is only found at concentrations several orders of magnitude lower than the amount shown to have an effect on corals (Lange, 1985; McAuliffe et al., 1975 and 1981; Knap et al., 1985). In the Western Gulf, the East Flower Garden Bank crests the shallowest at 15 m. Therefore, a surface spill would likely have no impact on the biota of the East Flower Gardens or other topographic features because any oil which might be driven to 18 m or deeper would be well below the concentrations needed to effect an impact.

If the one large and two medium spills were from seafloor sources, the impacts on topographic features could be different. A seafloor spill could occur from a pipeline rupture, a leak, or from an oil well blowout. (The impacts from a blowout other than the release of oil into the water column are discussed under the impacts from blowouts below.) The biota of the topographic features of the Western Gulf could be significantly impacted by a seafloor oil spill. Because of the lease stipulations, there would not be a seafloor spill directly over a sensitive topographic feature. However, oil spilled from a seafloor source may be entrained and transported for great distances in subsurface currents. This was the case for the Ixtoc-1 spill, where some oil released into the water column at the seafloor circulated in the Gulf below the surface for months before reaching the Texas coast (Section IV.B.6.b.). Such oil at depth could come in contact with the biologically sensitive topographic features (banks) of the Western Gulf. In addition, a surface spill very near one of the banks would have significant effects. Ten blocks in proximity to the topographic features will be expected to be leased as a result of the Western Gulf sale. From these leases, 25 exploratory wells and 2 platforms can be expected. Thus, the potential for subsurface spill in proximity to the banks exists. The effluents could impinge directly upon the edge of the bank. Impacts could then be serious to the local biota. Destruction of the biota of such areas may have severe and long-lasting deleterious consequences on the specific commercial and recreational fisheries habitats affected, such as loss of habitat, loss of species (including prey species), destruction of hard substrate, and change in sediment characteristics, all of which may result in the reduction or loss of one or more fisheries. These areas also have intrinsic biological, ecological, and aesthetic values of their own which would be lost by such activities.

The probability of an oil spill occurring at all is low in the Western Gulf. The probability of the spill being from a seafloor source is even lower. Even if a seafloor spill were to occur, the spill would have to come into contact with a biologically sensitive feature. The fact that the topographic features are widely dispersed in the Western Gulf, combined with the probable random nature of spill locations would serve to limit the extent of damage from any given spill to only one of the sensitive areas. The current which moves around the banks may steer any spilled oil around the banks rather than directly upon the banks. Although the potential impact to the topographic features from an oil spill would be very high, the risk of such an event occurring is very low.

Blowouts can present a serious threat (due to burying by resuspended sediments) to important biological resources if one were to occur near a topographic feature (Section IV.C.1.). Gas well blowouts generally pose far less environmental risk than do oil spills, resulting only in very high concentrations of suspended sediments and increased levels of gas in the water column very near the source of the blowout. The extent that oil or condensate is present in the reservoir, some liquid hydrocarbons may also be injected into the water column. The suspended sediments may be carried some distance by currents, but the bulk of the sediments are redeposited within a few thousand meters of the blowout site. Low-molecular-weight-hydrocarbons (gases) will dissolve in the water column until saturation is reached; both gaseous and dissolved low-molecular-weight hydrocarbons will be released into the atmosphere within a few days of a blowout without major biological effect. Liquid hydrocarbons will be diluted to background levels within a few thousand meters distance from the blowout site and will degrade with time. Refer to Section IV.A.4. for a discussion of impacts of documented blowouts in the Gulf of Mexico.

By establishing No Activity Zones, the stipulation will preclude blowouts directly on the sensitive banks. Nearby blowouts, however, may affect the bank if subsurface currents carry sediments or oil to the bank. Twenty-five exploratory wells and two platforms can be expected near the banks in the Western Gulf. In most cases, it is expected that the currents will sweep the contaminants around the bank rather than deposit them on the bank (Rezak et al., 1983). Some small fraction of the sediments or oil may reach a bank and come in contact with organisms; the extent of damage will depend on the amount of contaminant and the length of time it remains on the bank. Amounts are not expected to be high because of dilution, dispersion, settling, and current action (sweeping the contaminant around the bank). Length of time on the bank may be long for the heavier sediments, but these are likely to settle out rapidly and not reach the bank at all (Brooks and Bernard, 1977). A large blowout occurring near a biologically sensitive area would have severe environmental and consequences. Large amounts of the sediment resuspended by the blowout could smother the coral community causing mortality. Recolonization would be slow if at all.

Fortunately, blowouts are quite rare in the Gulf of Mexico. In addition to the low probability of occurrence, the blowout would have to be in close proximity to a topographic feature to cause an impact. The risk to the biota of topographic features from blowouts is therefore low.

Considerable mechanical damage would be inflicted upon the bottom by unrestricted routine oil and gas operations. The drilling operation itself would disturb some small areas. The presence of the structure can cause scouring of the surficial sediments (Caillouet et al., 1981). Anchors from support boats and ships, floating drilling units, and pipeline laying vessels do a great deal of damage to the seafloor. The area actually affected depends on depth of water, length of chain, size of anchor and chain, wind, and current. Anchor damage is the most serious threat to coral reefs. Anchoring biologically sensitive areas would include crushing and breaking of coral heads. Anchoring often destroys a wide swath of sessile organisms when the anchor is dragged or the vessel swings at anchor causing the anchor chain to drag the seafloor. Anchor damage from non-lease activity has been documented at the Flower Gardens (Section IV.A.4.).

Pipeline emplacement also causes considerable disruption to the bottom (Section IV.C.2.). It is estimated that six acres of the bottom is physically disturbed per mile of pipeline laid; some 2,300-6,000 yd^3 of sediment are resuspended per mile of pipeline, depending on the size of the pipeline and depth of trenching (burial). Add to this damage caused by the eight anchors of the pipelaying barge and it is clear that considerable damage would be done if such activities are conducted in sensitive coral areas.

A biological stipulation is being offered for consideration by the Secretary. The stipulation would impose a No Activity Zone on sensitive coral areas. Within this zone, no drilling or platform, rig, pipeline, or anchor emplacement would be allowed. Therefore, damage to these sensitive biological areas from oil and gas operations would be prevented.

The following seafloor features have not contained a stipulation in the past and are not covered by the stipulation: Phleger, Sebree, Big Adam, and Small Adam Banks. Phleger Bank crests at 122 m, deeper than the lower limit of the no activity zones (85 m or 100 m in the case of the Flower Gardens). The depth of the bank precludes the establishment of the Antipatharian Zone so that even though the banks is in clear water, the biota are typical of the nepheloid zone. This type of community is not sensitive to oil and gas activities and, therefore, is not covered by the stipulation. Sebree Bank is a low relief feature, approximately 3 m, and is subject to high sedimentation. The organisms on the feature are similar to those of the nepheloid zone. Sebree Bank attracts commercially and recreationally important finfish (Tunnell, 1981). Structure emplacement would enhance this attracting aspect. Impacts to the biota of the nepheloid zone of Sebree Bank or Phleger Bank are not expected to be significant. Big and Small Adam Banks are also low relief features subject to sedimentation. Rezak and Bright (1981) categorized these features as Class D banks, where protection is not recommended. A BLM study designed to map the bathymetry of the banks of the Gulf (Texas A&M Research Foundation, 1974) did not discern these features as mappable banks. Although designated in the table above that the banks may contain the Antipatharian

Zone, this designation is speculative (Rezak et al., 1983). The biota of Big and Small Adam Banks are not expected to be significantly affected, and therefore these banks are not included in the area covered by the stipulation.

Routine oil and gas operations discharge drilling muds and cuttings. Drilling discharges will cause turbidity and smothering of the benthos in proximity to the drillsite. Twenty-five exploratory wells and two platforms can be expected within 3 miles of the 22 sensitive banks in the Western Gulf. In the Gulf of Mexico OCS, about 90% of the discharge settles rapidly, usually within 1,000 m. Impacts to the biota may also result from the toxic components of the drilling muds. Most water-based fluids are non-toxic and their effects limited to the immediate vicinity of the discharge (NAS, 1983). Therefore, no significant effects on the biota of the topographic features are expected from drilling muds and cuttings discharges greater than 1,000 m from the feature.

Discharges within 1,000 m of the low relief topographic features would cause increased sedimentation onto the banks. The low relief features are frequently enveloped by the nepheloid layer which causes turbid conditions and sedimentation. The communities which exist on the low relief banks are adapted to life in a turbid environment. The discharged drilling muds and cuttings will be diluted considerably upon entrance into the water column. The discharge of muds and cuttings within 1,000 m of a low relief bank is not expected to affect the biota of the bank.

The biota of low relief, Claypile Bank is unique to the low relief banks. Claypile Bank contains the *Millepora*-sponge zone which is categorized as Class B (Rezak and Bright, 1981). This zone occurs at only three other banks. At these three high relief banks the zone would be protected by shunting provisions of the stipulation.

Shunting the effluent to the seafloor is an effective measure near topographic highs; however, at a low relief feature shunting would be counterproductive since the discharge would be deposited at the level of the biota sought to be protected. The *Millepora*-sponge zone of Claypile Bank is probably affected by the nepheloid layer and, therefore, adapted to periodic turbid conditions and sedimentation. However, it is also possible that the biota of the zone are at the edge of their tolerance level and would be adversely affected by the additional sedimentation caused by the drilling discharge. Therefore, the stipulation would require that discharges within 1,000 m of Claypile Bank be monitored to assess the affects on the biota of the bank. The monitoring provision would document the occurrence or non-occurrence of impact and allow for further measures to be implemented as appropriate.

At distances less than 1,000 m, all muds and cuttings discharges would be restricted by the stipulation. The stipulation would require that muds and cuttings discharge be shunted to within 10 m of the seafloor. Shunting of the effluent into the nepheloid layer of water confines the effluent to depths greater than the depths at which the sensitive biota exists (NAS, 1983). Even with worst case oceanographic conditions, the water from the base of a bank (containing also the shunted effluent) cannot flow from the base to the level of the living reef (Rezak and Bright, 1981). Thus, no significant effects on the biota of the topographic features is expected from discharges within 1,000 m where they are shunted to the seafloor.

The topographic features which are categorized as Category A or B banks (Rezak and Bright, 1981) and the uncategorized 29 Fathom Bank (see table above) are protected by additional restrictions imposed by the stipulation. These banks would require that effluents discharged within 1 nmi of the bank be shunted to the seafloor and development effluent discharged within 3 nmi be shunted. Although, as discussed above, most of the effects from drilling muds and cuttings are limited to within 1,000 m of the (surface) discharge, the additional preclusion of surface discharge out to 1 nmi and out to 3 nmi for development effluent is included for these banks because of their higher resource category and sensitivity. Small amounts of drilling discharge may reach the banks from unshunted wells drilled more than 1 nmi away; however, these amounts, where measurable, are extremely small and had no effect on the biota. Where drilling of many wells may take place near the same bank during the same time interval, as in development drilling, continued exposure to low levels of effluent may induce an effect on the biota. Due to the extremely low levels expected, any effect is not expected to be significant. However, because impacts from such activity have not been studied, the stipulation would require the lessee to shunt discharges from development operations within 3 mi of the high category banks. On a case-by-case basis, MMS may impose shunting of exploratory wells in the 3 Mile Zone in the unlikely event that numerous exploratory wells are planned during the same time interval at the same bank. Therefore, no impacts are expected from the discharge of drilling effluents.

Additionally, because of the extreme sensitivity and highest resource category of the Flower Garden Banks, discharges within 4 nmi of these banks must be shunted.

Produced water discharge is sometimes cited as a potential hazard to the biota of topographic features. Produced water is relict seawater associated with produced hydrocarbons. It contains high concentrations of inorganic salts ranging from a few milligrams per liter to 350,000 mg/l. Hydrocarbons and organic compounds may be present in parts per million levels (Offshore Operators Committee, 1975). The study of the Buccaneer oil field offshore (USDC, NMFS, 1977) reported that produced water was discharged at a rate of 138 m^3 per day between January

1975-February 1976. The average oil content of this produced water was 25.1 ppm. Near-platform macrobenthic populations were depressed and had a high turnover rate as compared to the surrounding sea bottom; this may have been a result of increased scour action around the platform structure itself, but no cause-effect relationship was established. OCS Order No. 7 requires that all discharges must meet USEPA standards which allow no more than 72 mg/l daily maximum of oil and grease discharge and 48 mg/l maximum monthly average (72 mg/l is equivalent to 72 ppm). Produced water discharges near topographic features would have to be shunted to near the bottom as required by the biological stipulation. Therefore, the biota of topographic features are not expected to be affected by the discharge of produced waters.

Conclusion

Activities resulting from the proposed action with the biological stipulation will have a very low impact on the biota of the topographic features.

Cumulative Impacts of the Proposed Action

Existing oil and gas lease operations, tankering, commercial and recreational activities, and natural events are potential impact producing factors which, along with the proposed action, may cumulatively impact that biota of the topographic features of the Western Gulf.

Oil and gas leasing has been increasing around the topographic features of the Western Gulf, and this trend is expected to continue in the future. Of the 200 blocks in the WPA which are within proximity to the topographic features, 126 are under active lease (Appendix A). Recent leasing near the banks has resulted not only from interest in "virgin" blocks but also from the leasing of expired or relinquished lease blocks (Figure IV-5). Cumulatively, a total of 340 exploratory wells and 20 platforms can be expected to have been drilled near the topographic features as a result of past lease sales and the proposed action. Many oil and gas operations on the previously leased blocks are subject to the provisions of a biological stipulation. These operations are not expected to have an adverse impact on the biota of the topographic features. Thus, the impact from cumulative oil and gas routine operations would be limited to the impacts from the operations conducted as a result of the proposed action. These impacts, as discussed above, if unrestricted, are expected to be very high.

Increased leasing near topographic features increases the probability that a blowout or seafloor oil spill may occur in proximity to a feature. Such an occurrence could be catastrophic as discussed above. However, even with the increased probability of occurrence, blowouts and seafloor oil spills are extremely rare in the Gulf, and the probability that the spill or suspended sediments would reach a bank is even less.

Anchor damage is considered to be the most serious threat to coral and coral-community areas (Bright and Rezak, 1978 and Rezak and Bright, 1981). The biological stipulation on the existing leases prohibits anchoring of industry-related vessels in the No Activity Zones; the stipulation does not affect other activities such as tankering, fishing, or recreational SCUBA diving nor would it prohibit industry-related anchoring on leases as a result of the proposed action. No data are available on the extent to which such anchoring may take place; however, all activities are known to occur in proximity to the topographic features. Nearly all the banks are near the established shipping fairways. The banks are apparently well-known fishing areas. Several of the shallower cresting banks are SCUBA trip destinations. Anchoring at a topographic feature by a vessel involved in any of these activities would cause significant damage to the biota, although the degree of damage would depend on the size of the anchor and chain. Damage to the East Flower Garden Bank from a tug was documented by CSA (1984) (Section IV.A.).

Anchoring at the banks may diminish as the shipping industry becomes aware of the damage their anchors do to the biota of the banks. To this end, the Gulf of Mexico Regional Technical Working Group passed resolution 85-1 recommending that DOI request the Secretary of Commerce to designate the Flower Garden Banks a no-anchoring zone on NOAA nautical charts. NOAA is preparing to place a notice on the charts which would identify the Flower Garden Banks as areas sensitive to anchoring. The Coral FMP (Section I.B.4.b.) also provides regulations for protection to coral from anchoring. However, the application of these regulations to nonfishing activities is uncertain. Therefore, there is potential for serious anchor damage to the biota of topographic features despite the regulations in place and proposed.

Treasure hunters have destroyed large areas of Bright Bank in the Central Gulf by using explosives to blast through the coral reef.

BLOCKS LEASED IN PROXIMITY TO TOPOGRAPHIC FEATURES WESTERN GULF OF MEXICO

(BASED ON 238 TOTAL BLOCKS)

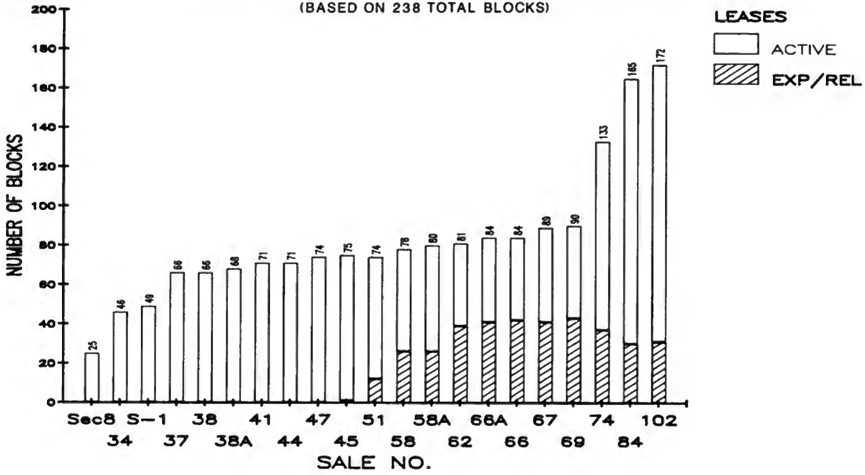


Figure IV-5

Impacts to the topographic features could occur as a result of operational discharges from the tankers. Due to the dilution factor and the depths of the banks, this activity is not expected to have a high level of impact on the topographic features.

Impacts from natural occurrences such as hurricanes are not expected to result to the banks. An industry-funded monitoring effort was underway at the Flower Garden Banks during the passage of Hurricane Alicia directly over the banks. The results of this study showed no effect on the biota of the banks due to Alicia.

Conclusion

The cumulative impact to the topographic features of the Western Gulf is expected to be very high.

(3) Impacts on Water Quality

The nature of impacts on ambient water quality from routine discharges resulting from the proposed action will be the same as those generic impacts for the Central Gulf (Section IV.D.1.a.(3)), with major differences being primarily quantitative in nature.

(a) Offshore

Impact Analysis

Impacts to offshore water quality will occur as a result of increased OCS activities in the Western Gulf. The addition of some 216 exploration/delineation wells, 276 development/production wells, 23 platforms, and up to 250 miles of pipelines are estimated for this area under the M scenario. Under this scenario, the discharge of an estimated 1.3-117.0 million bbls of formation waters, 2.24 million bbls of drilling muds, 0.25 million yds^3 of drill cuttings, 65,000 bbls of sand from drilling operations, and an average of 96,600 gallons/day of treated sanitary and domestic wastes from platforms may be expected as a result of this alternative (Table IV-36). Pipeline-related activities would result in the disturbance of up to 1.5 million yds^3 of sediment under the same scenario. Most offshore impacts would be localized around OCS facilities and will be of a temporary nature due to dilution and dispersion characteristics of the receiving body of water. Contaminants from marine transportation activities may enter the Gulf as a result of routine operational discharges or as a result of accidental spills. Activities consisting of supply boat and shuttle tankering trafficking in support of the proposed action would routinely discharge pollutants consisting of domestic waste products such as sewage, food waste, and trash or debris. Of primary concern would be problems related to the movement of crude oil and offshore loading practices, where the potential exists for accidental spills to occur. One oil spill greater than or equal to 1,000 bbls is assumed for the Western Gulf, according to the Oil Spill Risk Analysis (Section IV.B.2). Petroleum hydrocarbons introduced into the marine and coastal waters as a result of this spill may have varied effects on the local biota with impacts ranging from negligible to very high, depending on the resource impacted, the stage of weathering, and the local physical and meteorological parameters. Normal weathering processes, encountered with oil spilled into open water conditions, tend to detoxify the spilled oil by breaking down the toxic components of the oil. (See Section IV.B.4. for a discussion of fates and effects of spilled oil.)

Immediate effects would be brought on by increased drilling, construction, and pipelaying activities, causing an increase in water column turbidities of the affected waters. Such increases would have a nominal impact on the productivity of phytoplankton, but may cause a temporary clog in the respiratory and feeding mechanisms of numerous benthic and pelagic marine organisms within the area of construction. Pipeline construction activities may also result in the resuspension of some 1.5 million yd^3 of sediment and of settled pollutants, toxic heavy metals, and pesticides if present.

The discharge of an average of 96,600 gallons per day treated sanitary wastes from rigs and platforms will increase levels of suspended solids, nutrients, chlorine, and BOD in a small area near the point of discharge. However, as a result of treatment prior to discharge, as is required through USEPA's NPDES discharge permitting program, when combined with seawater these constituents are quickly diluted.

During the course of exploration drilling and workover phases resulting from the proposed action, the discharge of drilling fluids, cuttings, and sand will degrade the quality of the waters surrounding the proposed new platforms. Drilling fluid/cutting discharges will be continuous or bulk. Some 2.24 million bbls of drilling muds and 0.25

Table IV-36

M Scenario Estimates of Effluent Discharges Due to Increased OCS Activities as a Result of Western Gulf Sale 112

Year	Produced Waters (million bbls)	Exploration and Delineation Derived		Production Derived		Platform Derived Domestic and Sanitary Wastes (gal/day)	Sediment Disturbed by Pipelaying Activities (yd^3)
		Drill Cuttings (yd^3)	Drilling Muds (bbls)	Drill Cuttings (yd^3)	Drilling Muds (bbls)		
1986	-	-	-	-	-	-	-
1987	-	-	-	-	-	-	-
1988	-	3,577	31,850	-	-	-	-
1989	0.003 - 0.27	7,154	63,700	5,110	45,500	2,900 - 5,500	13,800 - 36,000
1990	0.004 - 0.36	13.286	118,300	7,665	68,250	5,800 - 11,000	13,800 - 36,000
1991	0.013 - 1.17	24,528*	218,400*	10,200	91,000	11,600 - 22,000	27,600 - 72,000
1992	0.065 - 5.85	20,440	182,000	17,885	159,250	20,300 - 38,500	41,400 - 108,000
1993	0.078 - 7.02	16,352	145,600	25,550*	227,500*	31,900 - 60,500	184,000 - 480,000*
1994	0.091 - 8.19	11,753	104,650	17,885	159,250	43,500 - 82,500	55,200 - 144,000
1995	0.117 - 10.53	7,154	63,700	17,885	159,250	52,200 - 99,000	41,400 - 108,000
1996	0.117 - 10.53*	3,577	31,850	10,220	91,000	58,000 - 110,000	27,600 - 72,000
1997	0.117 - 10.53	1,533	13,650	7,665	68,250	60,900 - 115,500	13,800 - 36,000
1998	0.110 - 9.90	1,022	9,100	7,665	68,250	63,800 - 121,000	142,600 - 372,000*
1999	0.098 - 8.82	-	-	7,665	68,250	66,700 - 126,500	13,800 - 36,000
2000	0.094 - 8.46	-	-	5,621	50,050	***	-
2001	0.086 - 7.92	-	-	-	-	***	-
2002	0.078 - 7.02	-	-	-	-	***	-
2003	0.065 - 5.85	-	-	-	-	***	-
2004	0.045 - 4.05	-	-	-	-	***	-
2005	0.032 - 2.88	-	-	-	-	***	-
2006	0.029 - 2.61	-	-	-	-	***	-
2007	0.023 - 2.07	-	-	-	-	***	-
2008	0.016 - 1.44	-	-	-	-	***	-
2009	0.010 - 0.90	-	-	-	-	***	-
2010	0.007 - 0.63	-	-	-	-	***	-
Totals	1.3 - 117.0	110,376	982,800	141,036	1.26 M**	66,700 - 126,500*	0.58 - 1.5 M**

*Denotes peak year
**Denotes million
***Quantities will vary depending upon platform occupancy, etc.

million yds^3 of drill cuttings are estimated to result from drilling activities associated with the proposed action. Continuous discharges may come from the solids control equipment on each platform, while bulk discharges (commonly known as active mud discharges or mud tank dumps) are discharges of large volumes of fluids and cuttings (16-190 m^3), at rates of discharge (80-100 m^3/h) and lasting for a period of 20 minutes to 3 hours (Mors et al., 1982; Petrazzuolo, 1981). Concern has been expressed regarding the effects of drilling muds and cutting discharges on the marine environment. Based on the findings of NAS (1983), Symposium (1980), Neff (1981), Petrazzuolo (1981), Menzie (1982), and others, their results suggest that the environmental risk of exploratory drilling discharges to most OCS marine communities are small. More than 96% of the whole drilling fluids tested in short-term experiments are classified as "slightly toxic" or practically "nontoxic." Toxicity does not seem to be a problem at the concentrations of material found at distances greater than 200-500 m from the discharge point, and not at distances greater than 1,000 m. Much of the toxicity of the mud aqueous faction of drilling fluids appears to be attributable to volatile organic components, which may include petroleum hydrocarbons and by products of lignosulfonate and lignite whereas suspended solids may cause mortality in sensitive species and juveniles by clogging and damaging gill epithelia. Benthic infauna tend to be affected to the greatest extent by offshore drilling waste disposal, but most of the studies suggest that impacts are restricted to an area within 300-500 m of the discharge site. Although dilution is extremely rapid in offshore waters to the extent that every substance measured in the water column, including turbidity, is at background by a distance of 1,000-2,000 m, uncertainties regarding effects still exist for low energy depositional environments which experience large inputs of drilling discharges over long periods of time. For a more detailed discussion of drilling fluid/cutting discharges on the marine environment, see Section IV.A.4.a.

Produced water is by far the largest quantity of waste to be discharged during normal oil and gas operations. Up to 117 million bbls of these waters are estimated to result from the proposed action. The majority of these waters will be discharged directly to the surface waters surrounding the individual platforms; however, in more sensitive areas and in some instances they may be piped ashore and treated for further disposal below ground, on land, or into coastal waters. The effects of produced waters on marine flora and fauna have been examined in laboratory bioassays and several case studies of existing production fields. Concern has been expressed regarding the individual synergistic and antagonistic effects of the various constituents of these waters, but the separation of components effects has not been possible in either case studies or bioassays. In production field case studies, the discharges of other wastes such as drilling fluids and deck drainage has complicated delineation of the source of trace metals and hydrocarbons while there have been no laboratory studies which identify the cause of produced water toxicity. Regional variations in the content of the produced water, as well as temporal changes in its composition during the life of a given well, have also complicated investigations on the effects of this production waste. The published literature indicates that produced waters and brines are only slightly toxic (1%-10%) to practically non-toxic to most marine organisms, using those standards commonly cited for describing acute toxicity (Sprague, 1973 and Day, 1978, both cited in Rose, 1981). The limited toxicity data available for juvenile and larval stages of shrimp and fish suggest, however, that immature individuals may be more sensitive than adults to the effects of produced waters. The sublethal effects of produced waters have also been examined during laboratory and field investigations and generally suggest that detrimental effects would not occur at concentrations of produced waters which could be reasonably expected near the offshore discharge rates (Arctic Laboratories Limited et al., 1983).

In contrast to the lack of laboratory bioassay data, the effects of produced water have been examined in several case studies of offshore production areas; the most detailed of these have been completed in the Gulf of Mexico. Of those conducted within the Gulf, the only significant effects on biota to be documented occurred when produced waters were discharged into shallow bays and estuaries. Mackin (1973) reported that produced water discharges totally destroyed the benthic community within 15 m of the discharges in a shallow (2.4 m) Texas estuary. Some mortality was observed at a distance of 91 m; however, a zone of increased productivity was found from 122 m to several thousand meters from the discharge. Based on studies conducted in Trinity Bay, Texas (Armstrong et al., 1979, cited in Goodman and Troake, 1982) no benthic organisms survived within a 15 m radius of the produced water discharge in water depth of 2-3 m. Low benthic biomass extended to a distance of 150 m from the outfall; no adverse effects were observed at 455 m.

Concentrations of trace metals in produced waters typically exceed those concentrations found in seawater by an order of magnitude or more (Tables III-2, IV-11, and IV-12). In a review of environmental aspects of produced waters, Koons et al. (1977) cite an increasing body of evidence which indicates that natural processes reduce the activity and toxicities of trace metals dissolved in seawater as a result of binding with organic substances. The low toxicity of trace metals is substantiated by bioassay studies which indicate that most marine organisms tolerate relatively high concentrations of produced waters. However, bioaccumulation of metals and subsequent sublethal effects remain areas of potential environmental concern. The existing data, however, neither confirms nor denies the potential for bioaccumulation of trace metals.

Marine flora and fauna may be affected by several other components and properties of produced waters, including its high salinity, temperature, content of organic compounds, low DO content and radionuclides; however, all investigators have agreed that rapid dilution and turbulence at the discharge point limit the zone affected by these properties (e.g., Mackin, 1973; Gallaway, 1980; Bender et al., 1979; and Reid, 1980). Although the distance required prior to the background levels being reached will vary with volume of produced water discharged and its particular characteristics, several investigators suggest that these levels are reached within a few meters from the discharge point, even in relatively shallow waters.

Offshore water quality degradation will occur within the immediate vicinity of exploration and production sites with high impacts expected to occur within a few meters to tens of meters from the discharge source. These impacts, however, will decrease to very low with distance (500-1,000 m) from the source.

Conclusion

As a result of the proposed action, the impact to offshore water quality in the Western Gulf is estimated to be low.

Cumulative Impacts

In addition to the impacts discussed for the proposed action, impacts from existing Federal OCS oil/gas leases and activities (Table IV-6); existing oil/gas leases and activities in State tidelands; tankering of petroleum products and foreign crude oil; and other commercial, military, and recreational offshore activities (Section IV.A.2.c.) should be considered as cumulative impacts on offshore water quality.

Increased oil/gas exploration and development activities in the Western Gulf will contribute to the cumulative impacts on offshore water quality in this region. These activities, along with ocean dumping and increased vessel traffic, are among the contributions to areawide water quality degradation. For a discussion on other factors considered to cumulatively impact water quality, see Section IV.D.1.a.(3) under offshore water quality, Cumulative Impacts.

Approximately 55 mobile rigs and 256 platforms (multiwell) currently operate in the Western Gulf Federal OCS. The construction of several additional pipelines from existing lease blocks in both Federal and State waters may occur in the future as a result of increased development activities in these areas.

The addition of some 1,435 exploration/delineation wells, 1,836 development/production wells, 153 platforms, and up to 1,480 miles of pipelines are estimated for this area as a result of the proposed action, future and prior OCS sales. This could result in the discharge of up to 1.0 billion bbls of formation waters, 1.49 million bbls of drilling muds, 1.67 million yds^3 of drill cuttings, and an average of 0.64 million gallons/day of treated sanitary and domestic wastes from platforms. Pipeline-related activities could result in the disturbance of up to 8.9 million yds^3 of sediment.

Offshore waters will therefore be subject to cumulative impacts from discharges of drilling fluids, formation waters, and other effluents which add burden of both toxic and nontoxic materials to the water column (Table IV-6). However, the natural processes of dispersion, degradation, and sedimentation will result in immeasurably low concentrations of these materials within a few meters to a few kilometers of the discharge site, resulting in low cumulative impacts.

Conclusion

The overall cumulative impacts on offshore water quality in the Western Gulf as a result of the proposed action and other non-OCS-related factors can be expected to be very high.

(b) Onshore

Impact Analysis

Onshore water quality degradation will occur as a result of increased nonpoint and point sources of pollution, especially in those areas of Texas (Sabine Pass to Lavaca Bay) where water quality problems persist. Impacts to onshore water quality will occur as a result of runoff from construction and operation of onshore facilities supporting expanded OCS activities in this region. The construction of up to 40 miles of onshore pipeline will create non-point source increases in surface runoff to nearby streams and rivers. Nonpoint source impacts may be minimized by controlling erosional effects generated within construction site boundaries, with several of the adverse impacts being localized and prevented from having offsite impacts to water bodies in the vicinity of these activities. Any increase beyond normal background levels would be temporary and of a limited duration. Point source increases would also occur from effluent discharges related to OCS-support activities, primarily the discharge of OCS produced waters piped ashore for treatment and discharge; however, any potential adverse impact can be mitigated by Federal and State water pollution control regulations and permitting.

Accidental spillage and chronic discharge of oils and fuels, in connection with the offloading of crude from shuttle tanker and barge activities, and fueling activities associated with supply boat support may occur as a result of the proposal. Although many of the smaller chronic discharges will go unnoticed, spills of a sizeable nature could cause very high impacts to areas adjacent to the spill. Though many ports and harbors require cleanup and containment equipment near these activities, this is not a USCG requirement.

As indicated in Section IV.A.4.a., up to one-half of the produced waters generated from OCS activities could be piped ashore for treatment and disposal into coastal waters. Produced waters which are piped ashore are subject to treatment prior to discharge, according to Federal and State regulations and permitting requirements; however, it should be noted that this treatment is only used in the extraction of oil and grease contaminants. These waters may therefore contain high concentrations of TDS, oxygen demanding wastes, toxic heavy metals, aromatic hydrocarbons, and environmentally high levels of radionuclides. In open ocean situations the discharge of these components appears to contribute minor impacts to the surrounding discharge area; however, in shallow semi-enclosed estuarine environments, impacts could be extremely high depending on the physical and biological components of each system. Additional information on location of discharge sites, daily discharge rates at each site, and the nature of the environment (background levels, etc.) in each area will be needed to determine the extent of impacts, if any.

Although onshore water quality impacts are estimated to be low, effluents discharged in connection with OCS-support facilities, suggested as having little or no impact, may be extremely damaging when released into sensitive habitats having a reduced capacity for pollution assimilation.

Conclusion

The overall impact to offshore water quality is estimated to be low.

Cumulative Impacts

In addition to the impacts discussed for the proposed action, impacts from existing oil/gas leases and activities in State tidelands and onshore (Section IV.A.2.d.) and other agricultural, municipal, and industrial activities (Section IV.A.2.d.) should be considered as cumulative impacts for onshore water quality.

Increased oil/gas exploration and development activities in the Western Gulf will contribute to the cumulative impacts on onshore water quality in this region. These activities along with current and future activities associated with State tidelands' oil and gas operations, industrial and municipal waste discharges, ocean dumping, and increased vessel traffic are among the contributions to areawide water quality degradation. For a discussion on other factors considered to cumulatively impact water quality, see Section IV.D.1.a.(3) under onshore water quality, cumulative impacts.

Approximately 40 platforms (multiwell) are currently operating in the Western Gulf State waters (1985). An unknown number of additional structures may be constructed as a result of resource development in State-owned coastal waters. The construction of several additional pipelines from existing lease blocks in both Federal and State waters may occur in the future as a result of increased development activities in these areas. Pipeline-related activities resulting from future and prior OCS sales could result in the disturbance of up to 7.38 million yds^3 of sediment.

The addition of some 6 new service bases (W-1 (3), W-2 (2), and C-1/C-2 (1)), 2 new pipe coating yards (W-1 (1) and W-2 (1)), 10 new pipeline landfalls (W-1 (5) and W-2 (5)), up to 200 miles of pipeline (W-1 (100) and W-2 (100)), 2 new platform fabrication yards in (W-1 (1-2)), and 3 new gas processing plants (W-1 (2) and W-2 (2)) could result from the proposed action, future and prior OCS sales in this area. Onshore water quality degradation will occur as a result of increased nonpoint and point sources of pollution associated with construction and operation of this new onshore infrastructure.

Offshore and nearshore waters will therefore be subject to cumulative impacts from discharges of drilling fluids, formation waters, and other effluents which add burden of both toxic and nontoxic materials to the water column.

Conclusion

The overall cumulative impacts for onshore water quality in the Western Gulf as a result of the proposed action and other non-OCS-related factors can be expected to be very high, primarily in those highly urbanized and industrialized coastal areas currently experiencing water quality problems.

(4) Impacts on Air Quality

For a generic discussion of impacts on air quality, see Section IV.D.1.a.(4).

Impact Analysis

The ambient air quality in the WPA is generally better than the national standards with those exceptions designated as nonattainment areas. Additionally, there are no PSD Class I areas in the Western Gulf. All nonattainment areas in the WPA are identified below:

Cameron, Texas
  Nonattainment - Primary - TSP
Nueces, Texas
  Nonattainment - Primary - TSP and O_x
Galveston, Texas
  Nonattainment -Primary - O_x
Jefferson, Texas
  Nonattainment - Primary - O_x
Brazoria, Texas
  Nonattainment - Primary - O_x
Harris, Texas
  Nonattainment - Primary - O_x, TSP

Onshore, it is expected that no new refineries and no new gas processing plants in the Western Gulf will be needed. Offshore, 216 exploration and delineation wells, 276 development wells and 23 additional platforms will be utilized.

Catastrophic events such as oil spills and blowouts have the potential to create localized air quality problems. Table IV-42 of the Final Regional EIS shows the potential levels of emission due to evaporation from oil spills. As discussed in Section IV.B.3. and as shown in Table IV-20 of the Final Regional EIS, it is expected that approximately 45% of a spill can be lost due to evaporative losses during the first 10 days. In the Western Gulf, one oil spill greater than 1,000 bbls is assumed to occur as a result of Alternative A. Significant degradation of onshore air quality is not expected due to oil spills. If degradation of air quality were to occur in nonattainment or PSD areas, the consequences are assumed to be more serious than if it occurred elsewhere.

Blowouts, also being nonroutine events that may persist for many days, emit substantial levels of NO_x, SO_x, CO, and TSP when associated with fire. These emissions can be considered a point source and have the potential of dispersing over land areas under certain circumstances. This depends on the location of the event and local wind conditions. Emissions from sources farther offshore have little potential of degrading onshore air quality; however, if such an event were to persist inshore for some time, it may degrade onshore air quality to an unknown extent. If these events affect any nonattainment or PSD Class 1 area, the consequences would be more serious than if it occurred elsewhere.

An unflared blowout in an area where sour gas exists could present health hazards with a radius of approximately three miles from the source. Should an event occur, concentrations of H_2S, content of gas, local wind conditions, and other factors would offset the level of impacts of the event. Uncontrolled emissions of this nature are unlikely to cause hazards onshore if the source is further than approximately 4-5 miles offshore. Off Texas, the Federal OCS is over 10 miles from shore.

Catastrophic events are not possible to predict in time and location. Effects from these nonroutine activities are highly dependent on the distance offshore and the proximity to a nonattainment or PSD area and higher impacts will occur if these events affect nonattainment or PSD Class 1 areas.

In an attempt to estimate the amount of operational emissions produced as a result of Sale 112 for a peak year of activity, air emissions data were compiled for exploratory drilling and platform operations. Typical emissions for exploratory drilling are shown in Table IV-14 and are based on studies conducted by USEPA for offshore activities. Emissions for a major platform operation is presented in Table IV-15. Emissions shown in this table are based on five years of air emissions data submitted to MMS in the Gulf of Mexico by industry operations.

Table IV-37 displays air emissions estimates under the proposed action using M Scenario assumptions. Since the greatest impacts would result during the period of highest activity, estimates are made for the peak activity years. A total of estimated emissions resulting from the proposed action is provided. The volume estimated assumes all activity occurs in the same peak year. Since all peak years are not conterminous, the estimate is assumed to be high. It should be noted that the total emissions estimated in Table IV-37 are based on values provided in Tables IV-14 and IV-15 and are not based on a detailed inventory of located emissions.

Table IV-37

Air Emissions for Peak Years under M Scenario Assumption
Western Planning Area
(tons/year)

	NO_x	CO	SO_x	VOC	TSP	Number of Wells/ Platforms	Peak Year
Proposed Action							
Exploratory Drilling	494.4	72.5	33.1	16.3	-	48	1990
Development/Production Drilling	515.0	75.5	34.5	17.0	-	50	1992
Platforms[1]	432.0	96.8	100.8	12.8	1.2	4	1992
Total	1,441.4	244.8	168.4	46.1	1.2		

[1] Assumes all platforms are major platforms capable of producing emissions.

The impact of OCS emissions resulting from the proposed action cannot be measured with available information. The spacial distribution of rigs and platforms, the temporal distribution over time, and the specific equipment producing emissions are unknown. However, it is assumed the proposed action will distribute offshore activity throughout the area. Subplanning area W-3 has the least activity and is a significant distance from, and does not adjoin, any coastal subarea. Subplanning areas W-1 and W-2 have the highest expected activity offshore and are located adjacent to land areas. In subplanning areas adjacent to coastal areas, the activity ranges to a maximum of 126 exploration and delineation wells, 170 development wells, and 14 platforms in subplanning area W-2. Subplanning area W-1 is expected to have 60 exploration and delineation wells, 38 development wells, and 3 platforms. Emission controls or offsets are not expected to be necessary for onshore facilities.

Of the coastal counties adjacent to offshore areas where the majority of development will occur, the ones most likely to be adversely impacted by this activity due to their unique status as nonattainment areas are Cameron, Nueces, Galveston, Harris, Jefferson, and Brazoria Counties, Texas. There are no PSD Class I areas in the WPA.

The expected level of offshore activities adjacent to the above counties is low. The maximum activity occurs in subplanning area W-2 with 14 platforms expected. Due to the low level of expected activity resulting from this proposal, the impacts from operational emissions are also expected to be low.

Additionally, no significant degradation of onshore air quality is expected from routine offshore operational emissions due to the regulatory control provided in 30 CFR 250.57. These regulations limit emissions from OCS facilities relative to significant levels outlined in Tables IV-29 and IV-40 of the Final Regional EIS. The regulations require that individual analysis of emissions produced by proposed structures in the Gulf of Mexico be performed. Since 1980 this analysis has shown that no structure proposed to date will exceed the exemption level. These regulations insure that impacts do not rise above some upper level (moderate) and will be considered nonsignificant. Impacts are controlled by regulation in this case such that public health and welfare are protected at an acceptable level. Impacts from uncontrolled events could be higher. The expected duration of impacts and a summary of expected impacts on the resource or concern are presented in Table IV-38.

Conclusion

The impact on coastal air quality from the proposed action is expected to be moderate in any nearby coastal area where an uncontrolled sour gas blowout occurred. Low impacts are expected in Cameron, Nueces, Galveston, Jefferson, and Brazoria Counties, Texas. Very low impacts are expected throughout the remainder of the coastal area of the Western Gulf.

Cumulative Impacts

In addition to the impacts discussed previously for the proposed action, impacts from existing Federal and State oil/gas leases and activities (Section IV.A.2.); tankering, vessel traffic, storage facilities, and refining of petroleum products and foreign crude oil; and other industrial, municipal, and mobile emissions should be considered as cumulative impacts on air quality.

Point source emissions from onshore activities, such as non-OCS oil and gas processing, power generation facilities, industrial processing or manufacturing facilities, waste incineration facilities, petrochemical storage facilities and mobile emissions sources (automobiles, waterborne transportation, etc.), are expected to increase at rates in proportion to the growth of population. Energy conservation, improved automobile emission controls, alternative (non-fossil fuels) energy generation facilities, and new waste disposal technology are factors that will determine the rate of change in air quality. Due to population in-migration throughout the Gulf region, the ambient air quality will probably degrade, over time, due to the overall effects of these activities and OCS-related activities. Ambient air quality is not expected to degrade beyond attainment standards where it is currently better than those standards or where PSD areas are located. The effects of all emissions on areas presently classified as nonattainment will be reduced over time so that attainment standards will be met. Controls or offsets may be applied to emission sources to meet these standards.

By far the most important OCS-related impact may be the cumulative effect of operational emissions on the coastal regions. Presently, a Gulf of Mexico study is underway to analyze inputs by use of the Offshore Coastal Dispersion (OCD) Model. This model will simulate the cumulative effects downstream of up to 250 point sources under various climatological conditions. Two major kinds of input data are required to drive the OCD Model: meteorological data and point source air emissions data. Currently, a Gulfwide air emissions inventory is being collected. The data is expected to be compiled by early 1987. Meteorological data will be available as needed.

An estimate of total emissions to be produced over a 20-year period is shown in Table IV-39. This estimate includes OCS infrastructure/activity assumed to be generated in the future by previously leased oil and gas resources in the CPA and existing platforms in place. Existing platform distances to shore may range from 3 to over 150 miles. An average annual figure is given.

Table IV-38

Summary of Expected Impacts on Air Quality - Proposed Action
Western Planning Area

Major Impact Producing Factor	Expected Impacts Onshore	Duration of Expected Impacts
Offshore Activity		
Catastrophic Events		
Blowouts with fire	Low to moderate	Short-term
Oil spills (major)	Low to moderate	Short-term
Release of sour gas (nonflared blowout)	Moderate	Short-term
Operational Emissions		
Exploration drilling	Low*	Long-term
Platform installation	Low*	Long-term
Development drilling	Low*	Long-term
Oil production	Low*	Long-term
Gas production	Low*	Long-term
Barge loading	Low*	Long-term
Onshore Activity		
Operations Emissions		
Refineries	No new expected*	Long-term
Gas processing plants	No new expected	Long-term

*Impacts from these activities are maintained below an upper limit (moderate) due to standing regulatory controls.

Note: Specific changes in conditions relative to levels of impacts are defined at the beginning of this section. Short-term is less than one year. Long-term is more than one year.

Table IV-39

Twenty Year Cumulative Estimated Offshore Air Emissions
Western Planning Area
(1,000 tons)

	NO_x	CO	SO_x	VOC	TSP	Number of Wells/Platforms
Leased Resources Expected to be Developed						
Exploratory Drilling	14.7	2.1	0.9	0.5	-	1,435
Development Drilling	18.9	2.8	1.3	0.6	-	1,836
Platforms	8.3	1.9	1.9	0.2	0.02	77[1]
Subtotal	41.9	6.8	4.1	1.3	0.02	
Existing Platforms	13.8	3.1	3.2	0.4	0.04	128[1]
Total	55.7	9.9	7.3	1.7	0.06	
Average annual	2.8	0.5	0.4	0.08	0.003	

[1] Assumes 50% of existing structures are major platforms.

No new oil refineries and three new gas processing plants are projected for the WPA. It is assumed that new source performance standards and best available control technology will be utilized on all facilities. Also, it assumed that additional controls or offsets may be required in some areas to meet air quality standards imposed by existing regulations. It can be assumed that impacts will be their highest (relatively) in the following counties which are classified as nonattainment areas: Cameron, Nueces, Harris, Galveston, Jefferson, and Brazoria Counties, Texas.

It should be noted that these identified nonattainment areas are classed as such for specific pollutants (TSP and O_x). Gas processing produces specific SOx emissions only. Therefore, these activities will not be a significant threat to the identified counties except that these activities may use a substantial increment of the allowable SO_x limit.

Offshore infrastructure in the WPA is estimated to be 256 platforms. Emissions from OCS installations is calculated at the time of permitting production facilities. Such factors as the distance to shore, climatological conditions, and emission producing equipment on each platform are analyzed as to their contribution to the degradation of air quality. Since records have been kept (June 1980), this air quality permitting analysis has identified a negligible contribution in the WPA.

Conclusion

As a result of the proposed action and other non-OCS-related activities, the overall cumulative impacts to air quality in the Western Gulf will be moderate.

(5) Impacts on Endangered and Threatened Species

An endangered species consultation pertaining to proposed Gulf of Mexico OCS oil/gas lease sales was held with FWS and NMFS. The biological opinions from these agencies (Appendix C) indicate that leasing and exploration activities associated with the proposed action are not likely to jeopardize the continued existence of the listed species considered in the consultation or result in the destruction or adverse modification of their critical habitat. On January 29, 1986, a memorandum from the FWS Southeastern Regional Office concurred with MMS's December 30, 1985, determination that proposed Sales 110 and 112 do not represent a substantive modification of the proposed actions considered in earlier regionwide consultations and that formal consultation for these proposed sales need not be initiated at this time. Minerals Management Service is requesting a reinitiation of Section 7 consultation with NMFS to inspect new data that has recently been generated concerning marine turtles. The definitions of impact levels for endangered species are listed in Table S-4.

(a) Brown Pelicans

Impact Analysis

The major impact producing factors which could affect brown pelicans in the WPA include Federal offshore related oil spills, noise disturbance from aircraft and vessel traffic, pipeline placement, and coastal facility construction near nesting and feeding areas.

If an oil spill should occur and contact brown pelican feeding and/or nesting areas, the pelicans could suffer mortality or reduced productive capacity. Pelicans are vulnerable to oil spills because as they plunge-dive during feeding or rest on the water, an oil slick could contaminate their feathers. This could result in the ingestion of oil as the feathers are preened or oil could be ingested during feeding. Should the food source itself be contaminated with oil, additional oil may be ingested. Ingestion of oil has been shown to cause reproductive losses in many bird species (Section IV.B.5.). Oil spills contacting with nesting areas could also result in oiling of feathers and contamination of eggs or chicks, causing mortality.

There are four feeding and nesting sites inhabited by brown pelicans in the Western Gulf coastal area. The major breeding population nests at Pelican Island in Corpus Christi Bay, Nueces County, Texas. Other colonies nest at Deadman's Reef north of Rockport and Long Reef in Aransas Bay, both in Aransas County, Texas, and of Caroll Island in San Antonio Bay, Refugio County, Texas. The Texas population of brown pelicans is about 400-500 birds. Brown pelicans from Mexico feed along the lower west Texas coast.

The highest probability of an oil spill occurring and contacting brown pelican habitat in the Western Gulf, as a result of the proposed action, is about 3% in Brazoria County, Texas; other pelican habitat has less than a 0.5% chance of oil contact. Due to the low chance of oil spill contact, the expected level of impact to pelicans from oil spills is very low.

Noise disturbance from aircraft and vessel traffic during nesting season can cause pelicans to leave or abandon their nests, which could result in the loss of eggs and mortality of chicks and/or juvenile birds. About 2,925 offshore-related vessel trips are estimated to occur in the WPA as a result of the proposed action; this is about 2% of the total vessel traffic in the Western Gulf. Only the nesting site in Corpus Christi Bay is likely to experience moderate numbers of offshore-related aircraft and vessel traffic. This traffic usually does not approach close enough to nest sites to disturb pelicans because of minimum altitude restrictions and shallow water depth. The estimated impact on brown pelicans from noise disturbance as a result of the proposed action is very low.

The placement of pipelines and the construction of onshore facilities near pelican feeding and nesting sites not only removes habitat available for nesting sites, but also noise associated with human activity makes additional areas unavailable for nesting. Disturbance from pipeline placement is usually only temporary, unless the pipeline right-of-way is used for other purposes. One pipeline is estimated for subarea W-1 (Calhoun or San Patricio Counties) and one pipeline for W-2 (Matagorda, Brazoria, or Jefferson Counties). None of these estimated pipeline landfalls are near pelican nesting sites.

One service base is estimated for each subarea W-1 and W-2. It is likely the service base will be located in active port areas and are unlikely to be located near brown pelican nesting sites.

Conclusion

A very low level of impact on brown pelicans from potential offshore-related oil spills, aircraft/vessel traffic, and coastal construction is expected in the WPA as a result of the proposed action.

Cumulative Impacts

In addition to the impacts discussed previously for the proposed action, impacts from existing and future Federal offshore oil/gas leases and activities; existing oil/gas leases and activities in State tidelands; tankering of imported crude oil and petroleum products; and other commercial, military, and recreational offshore and coastal activities should be considered as cumulative impacts. The majority of "other impacts" are difficult to quantify.

Three large oil spills and a number of smaller spills could occur as a result of prior, proposed, and future offshore oil/gas activities. An additional 24 oil spills could occur as a result of Gulfwide tankering of imported crude oil and products. The highest cumulative probability of an oil spill occurring and contacting brown pelican feeding/nesting habitat along the South Texas coast is 15% in Nueces County and the lowest about 19% in Cameron County, Texas. However, the barrier islands in this area afford some protection against offshore-related oil spills contacting pelican nesting areas in Corpus Christi Bay. In addition, oil/tar balls from natural seeps, bilge dumping, and foreign tanker oil spills could also impact brown pelicans. During a recent (August 1985) brown pelican census for the Audubon Society along the Texas coast, 5% of the 256 pelicans sighted near Port Mansfield (Willacy County) and 12% of the 407 pelicans sighted near Corpus Christi (Nueces County) had oil on their breast feathers. The expected cumulative impact of oil spill contacts and other oil contamination on brown pelicans is estimated to be moderate.

Disturbance from aircraft and vessel traffic in the vicinity of pelican feeding/nesting areas near Corpus Christi, Texas, and feeding areas along the Texas coast is not likely to increase above current levels as a result of offshore oil/gas activities. The cumulative estimate for Federal offshore-related service vessel trips are 66,000 and 201,000 helicopter trips in the WPA. On an annual basis, service vessel trips are about 2% of the annual vessel traffic in the WPA. About 98% of the aircraft and vessel traffic in this area is unrelated to Federal offshore oil/gas activities, such as: commercial, military, and private aircraft; commercial and military tanker/cargo vessels; commercial and recreational fishermen; intracoastal tug and barge traffic; and maintenance dredging.

Estimates of cumulative offshore-related onshore construction (Table IV-6) are: 5 service bases; 2 pipeline installation bases; 2 pipe coating yards; 10 pipelines; 2 platform fabrication yards; and 2 gas processing plants requiring a total of about 3,575 acres in the Western Gulf coastal area.

Impacts that are unrelated to OCS activities but contribute to the major cumulative impact on brown pelicans would include the loss of habitat to commercial, military, recreational, and residential development in the coastal zone; dredging and draining of wetland and coastal feeding areas; high levels of oil and organic chemical contamination of coastal water and food sources by agricultural runoff and industrial wastes; the disturbance from aircraft, boat, and vessel traffic in nesting and feeding areas; entanglement in commercial and recreational fishing gear; collision with power lines and towers (Avery et al., 1980); and coastal storms and hurricanes cause flooding and destruction of nesting areas.

Conclusion

The cumulative impacts are expected to be moderate.

(b) Marine Mammals (Whales)

Impact Analysis

The major impact producing agents which could potentially affect whales include: Federal offshore-related oil spills, collision with offshore-related support vessels, and disturbance from offshore activities.

Based on laboratory research (Geraci and St. Aubin, 1982; Goodale et al., 1981; and Gruber, 1981), the most likely effects of oil on endangered whales are: (1) a mild deleterious but reversible effect on the skin; (2) possible eye irritation, which would be reversible unless exposure was prolonged; (3) possible short-term baleen fouling with possible feeding reduction for 1 or 2 days; (4) possible blowhole fouling and death due to respiratory stress for very young animals in heavy oil; and (5) temporary food reduction or contamination, and oil ingestion by whales. Potential but unlikely effects include: (1) possible mortality due to respiratory stress; (2) possible mortality to young or already stressed animals immediately after a spill, due to ingestion of oil or inhalation of vapors; and (3) possible mortality due to stress if individuals are already stressed. Mortality has not been verified for any whales due to an oil spill. Therefore, it must be assumed that, if deaths occurred, the percentage would be very low.

Although the endangered sperm whale is uncommon in the Gulf of Mexico region (Mead, 1975), it is probably the more numerous endangered whale species in this region (Table III-5). A few sperm whales have been sighted in the Gulf (Fritts et al., 1983). The major whale habitat in the Gulf is in deepwater, off the continental shelf, while most of the OCS oil/gas activities occur on the shelf.

The deepwater whale habitat is very unlikely (less than 10% chance) to be contacted by an oil spill resulting from this proposed action, and the chance of a whale contacting an oil spill resulting from this proposed action is very low.

As a result of the proposed action, offshore oil/gas-related vessel traffic is estimated to be about 2% of the total annual vessel traffic in the Western Gulf. The level of vessel collisions with marine mammals in the Western Gulf is unknown; no injuries or mortalities have been reported or documented in the Gulf of Mexico region. The level of impact to whales resulting from OCS-related vessel collisions in this area is expected to be very low.

About 216 exploration and delineation wells will be drilled, which may require additional seismic exploration. Underwater sounds from seismic activities and well drilling apparently do not pose a significant impact to whales (Malme et al., 1984, and Gales, 1982) (Section IV.A.4.g.). This activity is usually short-term and fairly localized near the source and is unlikely to cause a major impact on whales in the WPA as a result of the proposed action.

Conclusion

It is expected that offshore-related oil spills, collisions with offshore-related vessel traffic, and disturbance from OCS-related oil/gas activities will have a very low level of impact on whales in the Western Gulf as a result of the proposed action.

Cumulative Impacts

In addition to the impacts discussed previously for the proposed action, impacts from existing Federal OCS oil/gas leases and activities; future lease sales; existing oil/gas leases and activities in Texas nearshore waters; tankering of petroleum products and imported crude oil; and other commercial, military, and recreational offshore and coastal activities should be considered as cumulative impacts (Section IV.A.2.).

Three offshore-related oil spills (1,000 bbls or greater) and 24 oil spills estimated for Gulfwide tankering of imported crude oil could occur in the WPA. In addition, natural oil seeps, bilge cleaning, and imported oil spills could have adverse cumulative impacts on whales, and deepwater oil/gas exploration and development on the continental slope could effect sperm whales which feed on squid in deepwater areas. The expected cumulative impact of these factors on the whale population is estimated to be low.

The offshore oil/gas-related vessel traffic for the proposed action is less than 2% of the existing commercial, military, and recreational vessel traffic in the offshore areas inhabited by whales. About 259,000 vessel trips of all types were recorded for the WPA in 1981. Seismic exploration could occur on an estimated 1,435 lease blocks, and sound will be generated by an estimated 153 offshore platforms, 66,000 supply/crew boat trips and 20,000 aircraft trips. Additional sound is produced by commercial, military, and recreational vessels, aircraft, and by commercial and military sonar. The majority of these disturbances and noises are generally localized around the source and fairly short-term in duration. Cumulative impacts from disturbances and noises in the Caribbean Sea and Atlantic Ocean could also occur. The cumulative impact from these disturbances and noises on whales are expected to be low in the WPA.

Other impacts that are unrelated to Federal offshore oil/gas activities but contribute to a cumulative impact on whales include entrapment, injury, and mortality in fishing gear and underwater cables. Several whale species were hunted to near extinction during the 1800's, and commercial and subsistence hunting of some whales still continues. Ocean disposal of chemicals, radioactive wastes, and munitions could contaminate whale food sources.

Conclusion

The cumulative level of impacts is estimated to be moderate.

(c) Sea Turtles

Impact Analysis

The major impact producing factors which could potentially affect sea turtles in the WPA include offshore oil/gas-related oil spills, collision with offshore-related support vessels, and offshore-related pipeline construction across turtle nesting beaches.

Loggerhead and ridley turtles occasionally nest on South Padre Island, Texas (Visual No. 3 of Final EIS 94/98/102). No green, leatherback, or hawksbill sea turtle nesting has been reported in the WPA. Sea turtle nesting in the Western Gulf area occurs from April-August with peak nesting in June. Loggerhead, green, hawksbill, and

Kemp's ridley turtles forage off the Texas coast. Data from 1985 sea turtle strandings for the Texas coast indicate 89 loggerhead, 13 green, 1 leatherback, 4 hawksbill, 62 ridley, and 11 unidentified sea turtles, a total of 180 dead sea turtles found along the Texas coast in 1985 (USDI, NMFS, 1986).

Oil spills contacting a turtle nesting beach during egg incubation or hatching periods (July-August) could cause significant turtle mortality (Fritts and McGhee, 1981). Offshore oil spills could have a serious impact on sea turtles. Floating oil could increase the mortality of turtles by contacting the turtles when they surface to breathe and indirectly by affecting food sources. Recently, some NMFS head-started Kemp's ridley turtles released off Padre Island, Texas, were washed onshore dead from oil/tar ball contamination. Chemical analysis of the oil indicated a foreign crude oil source.

There is less than a 1% probability of one or more oil spills (greater than 1,000 bbls) occurring and contacting sea turtle nesting habitat along South Padre Island. As very few sea turtles nest along the Texas beaches, the level of expected impact is estimated to be low. There is less than a 10% probability of an offshore oil spill occurring and contacting sea turtles in the southwestern Texas area as a result of this proposed action. An offshore spill could contact sea turtles while they are basking, surfacing to breathe, or feeding and cause deleterious effects. Because of the low number of spills expected, about one (0.31) (Table IV-17), and the moderate numbers of sea turtles which occur in the WPA, the probability of a sea turtle contacting an oil spill offshore Texas as a result of this proposed action is low.

As a result of the proposed action, offshore oil/gas-related vessel traffic in the Western Gulf is estimated at about 2,925 trips. These trips are about 2% of the annual vessel traffic in the WPA. The level of vessel collisions with sea turtles in the Western Gulf is unknown. The level of impact to sea turtles resulting from OCS-related vessel collisions in this area is expected to be very low.

Two pipeline landfalls and two service bases are estimated for the proposed action, one each in coastal subareas W-1 and W-2.

No pipeline construction or service base is expected to occur in the vicinity of sea turtle nesting beaches in the Western Gulf as a result of the proposed action.

Conclusion

A low level of impact on sea turtles from potential offshore oil/gas-related oil spills, collisions with OCS-related support vessels, and pipeline construction is expected in the WPA as a result of the proposed action.

Cumulative Impacts

In addition to the impacts discussed previously for the proposed action, impacts from existing Federal offshore oil/gas leases and activities; future offshore leasing; existing oil/gas leases and activities in State tidelands; tankering of petroleum products and imported crude oil; and other commercial, military, and recreational offshore and coastal activities should be considered as cumulative impacts (Section IV.A.2.).

Cumulatively, three oil spills (greater than 1,000 bbls) resulting from offshore oil/gas operations and about 24 oil spills resulting from Gulfwide imported crude oil tankering could occur in the WPA. The highest probability of one or more oil spills occurring and contacting sea turtle nesting habitat along the southwestern portion of Padre Island is about 15% for Nueces County, Texas. These cumulative oil spills could contact sea turtles offshore and cause a serious impact to the endangered Kemp's ridley turtle population, which is already severely decimated in the Western Gulf. An unknown number of oil spills could result from oil development in the Texas tidelands. Also, oil/tar balls from natural seeps, bilge cleaning, and imported oil spills impact the Texas coastal area. The cumulative impact of oil spill contacts and other oil contamination in the WCA is expected to result in a high level of impact on marine turtles.

Collisions of offshore oil/gas-related support vessels with sea turtles could occur in Texas coastal areas; the frequency of collisions has not been documented and is believed to be infrequent. The cumulative offshore service vessel trips are estimated at 66,000 and helicopter trips at 20,000 (Table IV-6). Offshore oil/gas-related vessel traffic is about 2% of the annual commercial, military, and recreational vessel traffic in Texas waters.

Ten pipelines, 2 gas processing facilities, 2 pipeline installation bases, 2 pipe coating yards, 2 platform fabrication yards, and 5 service bases may be required (Table IV-6); these are unlikely to impact sea turtle nesting/feeding areas. Because the support facilities will probably be located in active port areas and because the occasional turtle nesting on Padre Island occurs on protected State/Federal areas, the cumulative impact of offshore oil/gas-related facilities in the WPA are expected to result in a low level of impact on sea turtles.

Impacts that are unrelated to offshore oil/gas activities but contribute to the major cumulative impact on sea turtles include: the loss of nesting beaches to commercial, recreational, and residential development along Texas beaches; very high mortality caused by commercial trawling, commercial longline fishing gear, and entanglement in crab pot lines; natural and man-induced predation of turtles and eggs on nesting beaches throughout the Gulf and Caribbean regions; oil/tar balls from natural seeps, bilge cleaning, and tanker spills; compaction of beach areas by vehicles and beach cleaning equipment; dumping of contaminated wastes and plastic materials into coastal waters; and collision with commercial, military, and recreational vessels. There were 180 turtle strandings along the Texas coastline during 1985 (USDI, NMFS, 1986).

Conclusion

The cumulative impact on sea turtles is estimated to be very high.

(6) Impacts on Coastal and Marine Birds

Impact Analysis

The major impact producing agents which could potentially affect coastal and marine birds as a result of the proposed action include offshore oil/gas-related oil spills, disturbance from onshore facility construction near coastal nesting areas, and displacement of birds from feeding and nesting areas due to air and vessel traffic. See Table S-4 for definitions of impact levels. Many of the coastal and marine birds in the WPA, which are susceptible to oil spills, are migratory and could be exposed to oil spills during their overwintering period (October-March).

Oiling of birds causes death from hypothermia, shock, or drowning; oil ingestion significantly reduces reproduction in some birds; and oil contamination of eggs by oil-fouled adult birds reduces hatchability. Indirect effects of oil pollution on birds include contamination, displacement, and reduction of food sources. Long-term contamination of food sources and habitats may cause chronic toxicity to birds through the accumulation of hydrocarbon residues and may affect their behavior, physiology, and reproduction.

Aerial surveys along the Texas coast during the Ixtoc I oil spill in 1979 found that the reduction in bird population during the period of oil impact was due to the birds' abandonment of polluted beaches rather than to bird mortality, since the population returned to normal levels soon after a tropical storm removed most of the oil from the beaches (USDC, NOAA, 1982). During the Ixtoc I spill, Chapman (1979) observed royal terns sitting along the high tide line on Texas beaches that were heavily oiled.

Numerous species of coastal and marine birds feed and nest in bay areas and along the Texas coast (Clapp, et al., 1982 and Texas Colonial Waterbird Society, 1982). The coastlines of Galveston and Chambers Counties in Texas have the highest probability (about 9%) of being contacted with oil (Table IV-20). The majority of the bird feeding and nesting habitat occurs inshore of the Texas barrier islands which affords some protection against offshore oil spills contacting these inshore areas. A low level of impact is expected to coastal and marine birds in the WPA from oil spills resulting from this proposed action.

Disturbance of coastal and marine birds nesting and feeding habitat from onshore construction and associated noise from air and vessel traffic could result in a reduction or elimination of birds that use the habitat for feeding or nesting. Dredging and the construction of pipelines and roads could change water flows that may result in complete conversion of a marsh ecosystem (Section IV.D.1.a.(1)).

It is estimated that two pipelines and two service bases (requiring a maximum of about 242 acres), one in each of subareas W-1 and W-2 could be constructed in the vicinity of Calhoun, San Patricio, Matagorda, Brazoria, or Jefferson Counties in Texas that may affect coastal and marine bird habitat in that area (Section IV.A.1.e.). The projected pipelines and service base facilities will probably be located in developed onshore areas; however, there is a potential that some coastal and marine nesting/feeding habitat could be impacted.

It is estimated that 2,900 vessel trips will result from the proposed action; this is about 2% of the annual vessel traffic in the WPA. The majority of the offshore oil/gas-related vessel trips will occur between port areas and offshore platforms. It is unlikely this vessel traffic will disturb inshore coastal/marine bird feeding/nesting habitat.

Conclusion

A very low level of impact on coastal and marine birds from potential offshore oil/gas-related oil spills, disturbance from onshore construction, and air/vessel traffic is expected in the Western Gulf as a result of the proposed action.

Cumulative Impacts

In addition to the impacts discussed previously for the proposed action, impacts from existing Federal OCS oil/gas leases and activities; future leasing; existing oil/gas leases and activities in State tidelands; tankering of petroleum products and imported crude oil; and other commercial, military, and recreational offshore and coastal activities should be considered as cumulative impacts (Section IV.A.2.).

Cumulatively, three oil spills resulting from OCS oil/gas activities and about 24 oil spills resulting from Gulfwide tankering of crude oil could occur in the WPA. The chance of one or more of these spills occurring and contacting coastal and marine bird feeding and nesting habitat along the Texas coastline is highest in Galveston and Chambers Counties in Texas with a 57% probability. Galveston Bay is an important feeding, nesting, and overwintering area for bird species such as the endangered peregrine falcon. Forster's and least terns, roseate spoonbills, reddish egrets, 25 species of overwintering waterfowl, and one of the largest laughing gull colonies along the north Texas coast. These oil spills could also contact birds feeding/nesting offshore causing contamination of feathers/food sources resulting in illness or death. Coastal and marine birds that migrate through more than one OCS planning area may also be exposed to oil spills in other areas. The expected level of cumulative impact on coastal and marine birds due to these spill contacts is estimated to be moderate.

Disturbance from offshore oil/gas-related aircraft and vessel traffic in the vicinity of bird nesting and feeding areas in the WPA is not expected to increase above current levels. The cumulative service vessel trips are estimated at 66,000 and helicopter trips at 20,000 over the 30 years of this oil/gas development. About 98% of the aircraft and vessel traffic in this area is unrelated to offshore oil/gas activities. As crude oil imports increase, there could be increased disturbance to bird colonies in this area.

Offshore oil/gas-related offshore construction is estimated at 10 pipeline landfalls, 2 gas processing plants, 5 service bases, 2 pipeline installation bases, 2 pipe coating yards, and 2 platform fabrication yards. It is expected that the majority of this onshore construction will be located near existing port facilities and is unlikely to impinge on coastal bird feeding/nesting habitat.

Other impacts that are not related to offshore activities but could contribute to the major cumulative impact on coastal and marine birds would include the loss of nesting and feeding habitat to commercial, military, recreational, and residential construction; potential construction of offshore oil ports or deepwater marine terminals; dredging and draining of wetland areas along migratory flyways and in coastal feeding and overwintering areas; high levels of oil/tar balls from natural seeps, municipal runoff, bilge cleaning, and foreign crude oil spills; entanglement in commercial and recreational fishing gear; collision with electric lines and towers (Avery et al., 1980); and coastal storms and hurricanes cause flooding and destruction of nesting areas resulting in bird losses. Agricultural runoff and industrial organic chemical wastes could cause direct mortality or indirectly cause the loss of food sources for avian species.

Conclusion

The cumulative impact is estimated to be moderate.

(7) Impacts on the Commercial Fishing Industry

For a generic discussion of impacts on fisheries resources, see Section IV.D.1.a.(8).

Impact Analysis

Six, fourteen, and three offshore platforms/structures are expected to result from the proposed action in subplanning areas W-1, W-2, and W-3, respectively, eliminating less than 0.1% (18-30 acres in W-1, 42-70 acres in W-2, and 9-15 acres in W-3) of the trawling area in each subplanning area (Table IV-40). The total trawling area

Table IV-40

Commercial Fisheries Resources and Impact Producing Factors
Western Gulf of Mexico

						Impact Producing Factors							
		Resources				Probability of One or More Large Spill Contacts[1]				Offshore Production Platforms (number)			
Subarea*	County/Parish/Land Segment	Annual Landings (million lbs)	Annual Landings (million $)	Trawling Area (million acres)	Open Bay (acres)	M Scenario	Aggregate[2]	Low Scenario	High Scenario	M Scenario	Cumulative	Low Scenario	High Scenario
W-1		31.4	68.8	6.6	-	n	45	n	n	6	66	2	11
	Cameron/1				-	n	1	n	n				
	Willacy/2				-	n	2	n	n				
	Kenedy/3				-	n	13	n	n				
	Kleberg/4				-	n	9	n	n				
	Nueces/5				-	n	15	n	1				
	Aransas/6				-	n	10	n	1				
	Calhoun/7				-	n	7	n	n				
W-2		148.5	80.0	7.6	285,355	13	76	4	22	14	66	5	26
	Matagorda/8				-	1	11	1	1				
	Brazoria/9				-	3	26	3	6				
	Galveston, Chambers, Harris (Galveston Bay)/10				285,355	9	57	n	16				
	Jefferson/11				-	n	24	n	n				
W-3	(Offshore only)	-	-	1.0	-	-	-	-	-	3	21	1	6
C-1	Cameron/12					n	-	n	n				
Total				15.2		14	95	4	25	23	153	8	43

n = value less than 0.5%.
*See Figure IV-1.

[1] Probability (expressed as percent chance) of one or more large (≥1,000 bbls) oil spills occurring and contacting the indicated land segments within 10 days.
[2] Related to the proposed action, prior sales, future sales in the 5-year OCS lease schedule, and imports of crude oil.

lost, 69-115 acres, would still represent less than 0.1% of the trawling area in the WPA. This loss of trawling area would result in a very low impact.

There is a 14% chance of one large spill (1,000 bbls or greater) and a 99+% chance of several smaller spills (< 1,000 bbls) occurring. The probability of the one large spill contacting open bays containing finfish and shellfish nursery and/or spawning grounds within subanalysis area W-2 is 9% (Table IV-40). This probability corresponds to the only open bay in the Western Analysis Area, the Galveston Bay system. A large spill contact with open bays could destroy fish eggs, larvae, and juveniles, and would disrupt commercial fishing in offshore areas. The result could be severe medium-term (1-3 years) effects on fisheries. However, the percent chance of one large spill occurring is low, 14%. The expected level of impact would be moderate. Finally, if the smaller spills contact open bays they could cause localized short-term effects with recovery likely to occur within one year.

Conclusion

A moderate impact is expected on the commercial fishing industry from the proposed action.

Cumulative Impacts

In addition to the impacts discussed for the proposed action, impacts from existing Federal OCS oil/gas leases and activities (Table IV-6); existing State tidelands oil/gas leases and activities (Section IV.A.2.b.); tankering of petroleum products and foreign crude oil; other vessel traffic and port congestion; and other commercial, military, and recreational offshore activities (Section IV.A.2.c.) should be considered as cumulative impacts on the commercial fishing industry.

In addition to the 23 platforms projected for the Western Gulf from the proposed action, an additional 130 are expected to result from previous lease sales. The total area lost to trawling (390-650 acres) would still represent less than 0.1% of the total trawling area in the WPA. There are 256 existing platforms in the Western Gulf. The total area lost to trawling under existing conditions (768-1,280 acres) would still represent less than 0.1% of the total trawling area in the WPA. This loss of trawling area would result in a very low impact.

The probability of one or more large spill (1,000 bbls) occurrences and contacts is 95%. The probability of contact with the Galveston Bay System, which contains finfish and shellfish nursery and/or spawning grounds, is 57% (Table IV-40). A spill contacting this system could result in severe medium-term (1-3 years in duration) consequences on invertebrate and vertebrate fisheries and could deter fishing. In addition, the probability of a number of smaller spill occurrences and contacts with the Galveston Bay System is very high, 99+%. These spill contacts are expected to result in localized short-term effects on commercial fisheries.

Commercial fisheries in the Gulf of Mexico are also impacted by activities and events other than the oil and gas industry. Competition between large numbers of commercial fishermen, commercial operations employing different fishing methods, and commercial and recreational fishermen for a given fishery resource may reduce standing populations. Also, fishing techniques which may take significant numbers of other species as by catch, such as trawling or gill netting, may reduce the standing populations of these as well as the desired species. In the Western Gulf, populations of red snapper and other reef fish appear to be declining, particularly nearshore, primarily due to fishing pressure from hook-and-line fishermen. Overfishing and taking of juveniles, as by catch in trawling operations, are also impacting red drum populations in Texas. Space use conflicts can also result from different forms of commercial operations and between commercial and recreational fisheries. Trawling and crabbing operations often lead to this type of conflict resulting in loss of fishing space or gear conflicts. Also, the loss of wetlands are being closely studied to determine in what way and to what extent this loss affects commercial fisheries.

Conclusion

The impacts resulting from the proposed action, plus the effects of these other factors, added to the widely varying baseline conditions resulting from natural environmental factors, may result in a high cumulative impact on the commercial fishing industry in the Western Gulf area.

(8) *Impacts on Major Shorefront Recreational Beaches*

Section IV.D.1.a.(8) presents a general discussion establishing chronic trash and debris and large oil spills (greater than 1,000 bbls) as the major threats to use and appreciation of recreational beaches exposed to Gulf of Mexico OCS leasing and development. Standards for judging the level of impact likely to result from OCS lease sales are also listed in Section IV.D.1.a.(8).

Impact Analysis

It is reasonable to expect that exploration and production on blocks leased in the Western Gulf of Mexico under the proposed action could lead to a large oil spill (Table IV-20), and the spill could be carried by wind, wave, and currents to interact with a major shorefront recreational beach in Texas.

One large oil spill (1,000 bbls or greater) could occur as a result of the proposed action. This has up to a 12% chance to contact Texas' containing major recreational beaches (Matagorda, Brazoria, and Galveston/Chambers Counties). Galveston beaches such as Stewart Beach, West Beach, or Galveston Beach are the most vulnerable (9% chance). A number of smaller spills could also occur and contact recreational beaches. As was noted from the Ixtoc and the Alvenus experiences such an interaction will lead to temporary beach closures (2-4 weeks), sand removal, displacement of recreational activity, and economic consequences which will directly affect the businesses and support services directly associated with the beaches impacted, and it can indirectly spread to the community if the spill effects and publicity persist or occur during peak season. Offshore operations associated with exploration, development, servicing, production, and product transmission from leases granted will result in floatable or semi-buoyant trash and debris entering the Gulf. This trash and debris is expected to chronically effect beach aesthetics and increase maintenance requirements. Much of the trash, debris, and refuse associated with the offshore industry is environmentally persistent materials which come ashore and remain within the beach zone until removed by man. Because of this persistence and Gulf transport mechanisms, trash from leases throughout the Central and Western Gulf are likely to impact Texas beaches. This problem and its effect on beach use and maintenance becomes most serious in its cumulative context. New operational practices, training, and worker awareness programs initiated in 1985 and focused on the beach litter problem is expected to minimize the level of indiscriminate and irresponsible trash disposal from OCS operations.

Conclusion

The proposed action is expected to have a low to moderate impact on major shorefront recreational beaches along the Texas coast.

Cumulative Impacts

In addition to the impacts discussed for the proposed action, impacts from existing Federal OCS oil/gas leases and activities (Table IV-6); existing State tidelands oil/gas leases and activities (Section IV.A.2.b.); tankering of petroleum products and foreign crude oil; and debris and trash on beaches should be considered as cumulative impacts on major recreational beaches.

Up to two large oil spills (1,000 bbls or greater) and a number of smaller spills area likely to occur and contact major recreational beaches in Texas (76% probability) or Louisiana (89% probability) under the cumulative scenario. Such spill contacts and industrial litter from offshore operations in the Western Gulf are expected to impact Texas and Louisiana recreational beaches in Galveston County and Cameron Parish, respectively. Consequently, there could be short-term disturbance causing temporary loss or displacement of water-related, nearshore recreational activity and associated economic activity on specific beaches actually impacted (Galveston Island State Park, Steward Beach, or Holly Beach).

Continued and expanded oil and gas operations in the Western and Central Gulf will contribute to an already serious problem of human and industrial debris on coastal shorefronts which detracts from the aesthetic quality of recreational beaches and increases the cost of beach maintenance programs. Other factors such as oil and gas development in Mexican waters, in State territorial waters, offshore commercial and recreational fishing, and merchant shipping, as well as recreational use of beaches themselves and natural causes, also contribute to the debris problem and oil spill risk currently existing on the major recreational beaches of the WPA. An evaluation and 1985 report by the Texas Coastal and Marine Council on the litter along Texas beaches estimated that 75%-90% of all trash and debris chronically impacting the shorefront is coming from offshore. Padre Island National Seashore is making special evaluations on the source and incidence of trash and debris and estimated 250 tons washed ashore on the 60 miles of the Seashore's beaches in August 1985. One hundred and thirty tons, or approximately one-half of the items by weight, were attributed to the petroleum industry by Seashore analysts. Studies of the source and incidence of beach litter and its effects on recreational use are continuing at Padre Island National Seashore and should demonstrate trash load trends and tourism implications in time. This information will also be very valuable in evaluating the effectiveness of mitigating measures already in place, as well as special efforts by industry leaders, designed to minimize the contributions of OCS oil and gas operations to this onerous problem. A recent analysis of 300 drums floating ashore during 1985 along approximately 100 miles of South Texas beachfront focused on Padre Island National Seashore indicates hazardous chemicals are a threat to the health and safety of beach use as well. Although very few of these barrels could be identified as coming directly from OCS operations, bad weather and accidents are known to cause some drums associated with oil and gas activity in Federal waters to be lost in the water and to contribute to the problem. Cleanup cost to remove trash and debris from south Texas beaches is estimated to exceed a million dollars a year. Based on data, information, estimates, and opinions provided to us by State and Federal park and beach administrators in Texas, we concluded it costs an average of over $4,000 per mile per year to remove oil and gas trash from major shorefront recreational beaches at current cleanup levels. Public funds for beach maintenance and cleanup are generally decreasing while the severity of the problem appears to be increasing. The transport mechanisms of the Gulf makes the problems particularly critical along South Texas beaches, especially along a 10-mile section of Padre Island National Seashore, where major longshore currents converge. Furthermore, the environmental persistence of plastics and other petroluem-based products and by-products, which are major components of today's domestic and industrial trash load, is compounding the problem of beach litter with time. The contribution to the trash and debris problem from all active OCS leases, which involves approximately 50,000 offshore employees, 4,000 production platforms, 200 drilling rigs, and 1,000 vessels, in the Central and Western Gulf is considered significant and increasing.

Conclusion

Overall, the estimated level of cumulative impact on Texas' major shorefront recreational beaches is expected to be very high, and oil and gas operations are contributing significantly to this impact.

(9) Impacts on Archaeological Resources

For a discussion of significance, see Section IV.D.1.a.(9).

(a) Historic

Impact Analysis of the Proposed Action

Of the 1,589 ships known to have sunk in the northern Gulf of Mexico between 1500 and 1945, only 110 have locations with enough accuracy to allow mapping (Table III-17). Of these 110 shipwrecks having known locations, 17 lie within the WPA.

One of these wrecks, the *U.S.S. Hatteras*, is the only one of the 17 shipwrecks with known locations in the WPA that has been groundtruthed and evaluated for National Register eligibility. Since the precise location of the *U.S.S. Hatteras* is known, avoidance by OCS oil and gas development will be required due to its National Register status.

Three more of the 17 ships date from the late nineteenth century. The remainder are twentieth century (Table III-19). The historical significance of these twentieth century ships is probably low, and most would not qualify for inclusion in the National Register of Historic Places.

Although relatively precise locations are known for only 17 potentially significant shipwrecks in the Western Gulf of Mexico (Table III-19), a zone within which most of the remaining reported shipwrecks should lie (Archaeological Resources Zone 1) was defined during the archaeological resources baseline study (CEI, 1977).

Each of these shipwreck sites would have to be assessed individually through archival research and on-site evaluation to determine their uniqueness and the amount of information they might provide to our Nation's maritime heritage, although, in general, any pre-twentieth century shipwreck has a high potential for containing significant archaeological information.

Offshore development could result in an interaction between a drilling rig, platform, pipeline, or anchors and an historic shipwreck. This direct physical contact with a shipwreck site could destroy fragile ship remains, such as the hull and wooden or ceramic artifacts, and could disturb site context. The result would be the loss of archaeological data on ship construction, cargo, and social organization of the vessel's crew, and the concomitant loss of information on maritime culture for the time period from which the ship dates.

Since the actual locations of 98% of the pre-twentieth century ships known to have sunk in the Gulf of Mexico are unknown (Table III-17), since the uniqueness or significance of the information they contain is presently unknown, and since the exact location of projected offshore development is unknown, the probability for an interaction between an impact producing factor and an historic shipwreck is uncertain. However, should an interaction occur, the potential exists for the loss of significant or unique archaeological information. The resulting impact would be high to very high.

Onshore historic properties include such sites, structures, and objects as historic buildings, forts, lighthouses, homesteads, cemeteries, and battlefields.

Presently unidentified onshore historic sites would have to be assessed after discovery to determine the uniqueness or importance of the data they contain. However, sites already listed on the National Register of Historic Places and those considered eligible for the Register (Visual No. 11) have already been evaluated as being able to make a unique or significant contribution to science. Of the presently unidentified coastal historic sites which could be impacted by onshore development, some may contain unique historic information.

Onshore development as a result of the proposed action could result in direct physical contact between construction of new onshore facilities and previously unidentified historic sites. This direct physical contact with an historic site could cause physical damage to, or complete destruction of, historic sites, structures, and artifacts, and could disturb site context. The result would be the loss of information on the history of the region and the Nation. Often information contained in historical sites is unrecorded in written historical accounts. A site which contains such previously undocumented information may be the only surviving source of that information.

Under the M Scenario, the number of acres projected for disturbance from new onshore facilities in the Western Gulf is 530. Due to the low amount of acreage projected for disturbance, the visibility of most onshore historic sites, and State and Federal archaeological resource laws which require consideration of historic properties if any State or Federal funding or permits are required for construction, the expected impact to coastal historic sites in the WPA as a result of the projected onshore development associated with Sale 112 is very low.

Should an oil spill contact a coastal historic site such as a fort or lighthouse, the major impact would be visual due to oil contamination of the site and its environment. This impact would probably be temporary and reversible with no actual loss of information. The probability of a large spill contact (1,000 bbls or greater) is low (a 6% chance, Table IV-20). Based on the criteria of significance outlined above, the expected impact to coastal historic sites from an oil spill would be very low.

Conclusion

The expected level of impact to historic sites in the Western Gulf as a result of the proposed action is uncertain, however, the potential exists for a high to very high level of impact.

Impact Analysis of the Proposed Action with the Archaeological Resource Stipulation

The archaeological resource stipulation pertains only to impacts associated with offshore development. It would reduce the potential for development associated impacts to historic shipwrecks by requiring that a survey be conducted within Archaeological Zone 1 prior to lease development. This survey, by recording evidence of shipwrecks on and beneath the seafloor, makes avoidance or mitigation of impacts to the shipwreck possible.

Generally, in the western portion of the Western Gulf where unconsolidated sediments are thicker, it is more likely that shipwrecks present within a survey area would not be detected by the side scan sonar. In this area (subplanning area W-1), the effectiveness of the survey in detecting historic shipwrecks of composite and wooden construction would be approximately 25%-30% (Volume 1, Section II.A.1.c.(2), Table II-2 of the Final Regional EIS). In this area, the stipulation would reduce the potential for a direct physical contact between an impact producing factor and a shipwreck by 25%-30%. This would not significantly reduce the potential for an interaction;

therefore, in the western portion of the WPA there would still be potential for a high to very high impact. In the eastern portion of the Western Gulf where shipwrecks are more likely to be detected by the side scan sonar, the potential for a direct physical contact between an impact producing factor and a shipwreck would be reduced by an estimated 90%. This is a sufficient reduction in probability that it can be assumed that little damaging interaction between an impact producing factor and an archaeological site would occur. Therefore, the stipulation would reduce the potential impact to historic shipwrecks in the eastern portion of the WPA from very high to very low.

Conclusion

The lease stipulation, if adopted, would not significantly reduce the potential for a very high impact in the western portion of the WPA. In the eastern portion of the WPA, the lease stipulation would reduce the potential for a very high impact to very low.

Cumulative Impacts of the Proposed Action

Other major factors which would affect significant historic archaeological resources in the Western Gulf include trawling, sport diving/commercial treasure hunting, hurricanes, channel dredging, previous oil and gas development, and chronic, low level hydrocarbon contamination.

The cumulative impact section for the Central Gulf provides a general discussion of the impacts related to sport diving/commercial treasure hunting and channel dredging activities.

The most intensive areas of trawling in the Western Gulf are represented by the areas outlining the centers of abundance for brown shrimp (Visual No. 4-1). The probable impacts of trawling on significant historic resources are discussed in the cumulative impact section for the Central Gulf. Based on this discussion, it is probable that the impact on significant historic archaeological resources in the Western Gulf due to trawling would be very low.

About one-third of the coast along the Western Gulf was hit with 16-20 tropical cyclones between the years 1901-1955 (DeWald, 1980). The other two-thirds had a slightly lower incidence of cyclones (11-15). Five major hurricanes also cut the Western Gulf between the years 1954-1977. The probable impact of tropical storms on significant historic resources is discussed in the cumulative impact section for the Central Gulf. Based on this discussion, it is probable that the impact on significant historic archaeological resources in the Western Gulf from tropical storms would be very high.

At the end of 1983, there were about 456 platforms in place and 2,430 wells had been drilled in the Western Gulf, as compared to the additional 70 platforms and 1,910 wells (exploration, delineation, and production) estimated to result from Federal OCS activity under the cumulative scenario. The general impacts of previous oil and gas development on significant historic resources are discussed in the cumulative impact section for the Central Gulf. Based on this discussion, it is probable that the impact on historic resources due to previous oil and gas development in the Western Gulf has been very high.

There is a 79% probability that one or more large spills (1,000 bbls or greater) and a number of smaller spills could occur and contact coastal archaeological sites (historic and prehistoric) under the cumulative scenario. In addition, it has been estimated that the annual input of petroleum into the Gulf from all sources approaches 2.3 million bbls. This chronic hydrocarbon contamination could have an impact on historic resources; however, since the impacts to historic sites from oil contamination are generally short-term and reversible, the expected cumulative impacts from oil contamination are estimated to be low.

Conclusion

The estimated level of cumulative impacts on the historic archaeological resource base in the Western Gulf is expected to be very high.

(b) Prehistoric

Impact Analysis of the Proposed Action

Prehistoric sites which are anticipated to occur offshore include all of the types of sites observed onshore such as shell middens, campsites, kill sites, and tool manufacture areas.

As the result of an MMS funded study (CEI, 1986), two possible prehistoric archaeological sites have been documented on the OCS. These occur in association with the ancient Sabine River valley offshore western Louisiana and eastern Texas. The results of this study demonstrate that, given the right set of geologic and environmental conditions, prehistoric sites on the OCS will have survived marine transgression and can be located and evaluated through seismic and sedimentary analyses.

Prehistoric archaeological sites on the OCS are important because the information they may provide on prehistoric human migrations, settlement patterns, subsistence strategies, and cultural contacts across now-submerged landmasses cannot be obtained from terrestrial sites. The information contained in these sites would therefore be scientifically significant, and probably unique.

Under the M Scenario, the maximum number of acres projected for disturbance from new onshore facilities in the Western Gulf is 530. Due to the low amount of acreage projected for disturbance, and State and Federal archaeological laws which require consideration of archaeological resources if any State or Federal funding or permits are required for construction, the expected impact to coastal prehistoric sites in the WPA as a result of the projected onshore development associated with Sale 112 is very low.

Should an oil spill contact a coastal prehistoric site, the potential for dating the site using Carbon-14 would be destroyed. However, if diagnostic artifacts are present in the site, loss of C-14 dating potential may not constitute a loss of unique information.

Previously unrecorded coastal sites may suffer direct physical impact from beach cleanup operations. Interaction of cleanup equipment with a site could destroy fragile artifacts of site features and could disturb the site context. The result would be the loss of information on the prehistory of North America and the Gulf Coast Region. Of the coastal prehistoric sites that may be impacted by beach cleanup operations, some may contain unique information; however, the probability of a major spill is low (a 6% chance, Table IV-20). Therefore, the expected impact to coastal prehistoric sites from an oil spill would be very low.

Conclusion

The expected level of impact to prehistoric sites in the Western Gulf as a result of the proposed action is uncertain; however, the potential exists for a high to very high level of impact.

Impact Analysis of the Proposed Action with the Archaeological Resource Stipulation

The archaeological resource stipulation pertains only to impacts associated with offshore development. It serves to reduce the potential for development associated impacts to prehistoric sites by requiring that a survey be conducted within Archaeological Zones 1 and 2 prior to lease development. This survey provides the high-resolution seismic data necessary to delineate areas having a high potential for the occurrence and preservation of prehistoric archaeological sites within a lease area. Avoidance or further investigation of potential site areas is then required.

It is estimated that the archaeological survey provided for by the lease stipulation in 90% effective in allowing identification and avoidance of high probability areas for site occurrence. This provides a sufficient reduction in the potential for an interaction between an impact producing factor and a prehistoric archaeological site, that it can be assumed that little damaging interaction would occur. Therefore, the stipulation would reduce the potential impact to prehistoric sites in the WPA from very high to very low.

Conclusion

The lease stipulation, if adopted, would reduce the potential for a very high impact to prehistoric sites in the WPA to very low.

Cumulative Impacts of the Proposed Action

Other major factors which would affect significant prehistoric archaeological resources in the Western Gulf include trawling, hurricanes, channel dredging, previous oil and gas development, and chronic, low level hydrocarbon contamination.

The most intensive areas of trawling in the Western Gulf are represented by the areas outlining the centers of abundance for brown shrimp (Visual No. 4-1). The probable impacts of trawling on significant prehistoric resources are discussed in the cumulative impact section for the Central Gulf. Based on this discussion, it is probable that the impact on significant archaeological resources in the Western Gulf due to trawling would be very low.

About one-third of the coast along the Western Gulf was hit with 16-20 tropical cyclones between the years 1901-1955 (DeWald, 1980). The other two-thirds had a slightly lower incidence of cyclones (11-15). Five major hurricanes also cut the Western Gulf between the years 1954-1977. The probable impact of tropical storms on significant prehistoric resources is discussed in the cumulative impact section for the Central Gulf. Based on this discussion, it is probable that the impact on significant prehistoric archaeological resources in the Western Gulf from tropical storms would be very high.

Because most channel dredging occurs at entrances to bays, harbors, and ports, there is a high probability for impacts to prehistoric sites because of high site densities in these areas. Assuming that some of the data lost have been unique, the impact to prehistoric sites, as a result of past channel dredging activities, would be very high. In many areas, COE now requires remote sensing surveys prior to dredging to minimize such impacts.

At the end of 1983, there were about 456 platforms in place and about 2,430 wells had been drilled in the Western Gulf, as compared to the additional 70 platforms and 1,910 wells (exploration, delineation, and production) estimated to result from Federal OCS activity under the cumulative scenario. The general impacts of previous oil and gas development on significant prehistoric resources are discussed in the cumulative impact section for the Central Gulf. Based on this discussion, it is probable that the impact on significant archaeological resources due to previous oil and gas development in the Western Gulf has been very. high.

There is a 79% probability that one or more large spills (1,000 bbls or greater) and a number of smaller spills could occur and contact coastal archaeological sites (historic and prehistoric) under the cumulative scenario. In addition, it has been estimated that the annual input of petroleum into the Gulf from all sources approaches 2.3 million bbls. This chronic hydrocarbon contamination could have an impact on prehistoric resources. The impacts associated with chronic hydrocarbon contamination are discussed in the cumulative impact section for the Central Gulf. Based on this discussion, the impact of chronic hydrocarbon contamination in the Western Gulf in the loss of significant prehistoric site data may be very high.

Conclusion

The expected level of cumulative impacts on the prehistoric archaeological resources base in the Western Gulf is estimated to be very high.

b. Impacts from Alternative B - No Action

Impact Analysis

All positive and negative impacts associated with the proposed action (as discussed in Section IV.D.2.) would be cancelled.

The opportunity would be foregone or postponed for development of the 0.13 billion bbls of oil and 1.87 tcf of gas in the Western Gulf. Development of alternative energy supplies as replacement resources for lost domestic production is discussed in Section IV.D.1.c.

Based on the resources estimated by MMS, Table IV-32 presents the energy equivalents that may be required from several alternative energy sources should this sale be permanently cancelled. For the purpose of clarity, this table has separately identified each potential alternative source of energy regarding substitution requirements. It is unlikely, however, that there would be a single choice between these alternative sources, but instead, some combined effort to further explore and develop many or all of these forms as a substitute for OCS oil and gas production. A detailed discussion of alternative energy resources is contained in Appendix I.

Conclusion

If no action is taken on this proposed sale, all environmental impacts that could have occurred under the proposed action will be avoided. Adverse socioeconomic impacts could include a loss of employment opportunities, payroll revenues, and tax revenues.

Cumulative Impacts

Although the impacts of the proposed action would not occur, the overall levels of cumulative impacts potentially caused by existing and future OCS leasing (excluding the proposed action) and other activities affecting the resources of concern are expected to be essentially the same as those summarized in Table S-3 and described in detail in Section IV.D.2.a.

c. Impacts from Alternative C - Delete Biologically Sensitive Offshore Habitats

This deletion alternative (Section II.B.3.) would delete the 56 unleased blocks of the total 200 blocks (these blocks are listed in Appendix A) which are on or near enough to biologically sensitive areas of topographic features of the WPA so that activities resulting from the proposed action could have a high probability of impacting these biota. The resource estimates for the proposed action would not be significantly reduced as a result of adopting this alternative. Therefore, the projected number of oil spills would also remain unchanged. Such a deletion would prevent any oil and gas activity whatsoever in the affected blocks (except for pipeline construction which could be prevented through the normal pipeline permitting procedures); thus, it would eliminate any impacts to the biota of the area from oil and gas activities conducted within the blocks. Essentially, the blocks which fall within 3 nmi of the 85 m isobath (4 nmi of the 100 m isobath at the East and West Flower Garden Banks) of the Category A banks and within 1,000 m of the Category C banks of the Western Gulf are considered to contain biota which could be harmed by oil and gas activities. Deleting this small percentage of the Western Gulf area should result in a very large reduction of the potential impacts to these high value biological resources.

The biological resources of the topographic features are considered very sensitive to potential impacts due to oil and gas operations; thus, this deletion alternative is presented in order to fully protect these resources. The proposed biological stipulation discussed in Section II.B.1.c.(1), while reducing the risks to very low, would not remove all risk.

Many of the topographic features of the Western Gulf are the surface expressions of salt domes which are often associated with oil and gas reserves. The recovery of such reserves would be prevented by the adoption of this alternative.

In addition, there are no significant changes in the levels of potential impact to historic or prehistoric archaeological resources when compared with the proposed action.

To the extent that deletion of these few blocks will reduce the oil and gas exploration and development activities of the proposed action and to the extenty that the resources expected to be impacted by the proposed action (such as endangered species, commercial and recreational fisheries, water quality, etc.) are found in those blocks, the impacts to those resources will be similarly reduced.

d. Low and High Find Scenario Analyses: Proposed Action

(1) Description

Low and High Find Scenarios (L and H Scenarios)

The L and H Scenarios are analyzed to provide information on the reasonably foreseeable range of potential exploration, development, and production activities and facilities, and related impacts that might occur as a result of the proposed action. The L Scenario is based on the low resource estimates for which there is a 95% chance that more than the amount estimated is present. The H Scenario is based on the high resource estimates for which there is a 5% chance that more than the amount estimated is present. These estimates are of the conditional, unleased, undiscovered, economically recoverable resources in the area being offered by the proposed action.

The resource and offshore infrastructure estimates related to the proposed action for both scenarios are included in Table IV-41. Resource and related infrastructure estimates compared to those for the M Scenario, are 58%-80% less under the L Scenario and 72%-92% higher under the H Scenario.

The estimated timetables for offshore exploration, development, and production activity are included in Table IV-42. Exploration and development activity is estimated to occur over a somewhat shorter time period under the L Scenario, while under the H Scenario a somewhat longer time period is needed compared to the M Scenario

Table IV-41

Resource and Offshore Infrastructure Assumptions: Western Gulf Sale 112 - Low and High Find Scenarios

	L Scenario	H Scenario
Resources Expected to be Developed[1]		
Oil (billion bbls)	0.040	0.250
Gas (tcf)	0.700	3.350
Annual Peak Production[2]		
Oil (billion bbls)	0.004	0.023
Gas (tcf)	0.070	0.302
Offshore Infrastructure		
Exploration and Delineation Wells	90	410
Platforms (Production)	8	43
Development Wells	100	520
Pipeline (miles)[3]	50	300
Transportation Assumptions		
Oil - Pipelined (billion bbls/%)	0.028/70	0.175/70
Oil - Shuttle Tankered (billion bbls/%)	0.012/30	0.075/30
Gas - Pipelined (tcf/%)	0.700/100	3.350/100
Shuttle Tanker Traffic (20,000 dwt/50,000 dwt)[4]	11/5	67/27
Offshore Discharges[5]		
Drilling Mud Material (million bbls)	0.9	4.2
Drill Cuttings (million cubic yards)	0.1	0.48
Formation Waters (million bbls)	0.4-36	2.5-225
Offshore Air Emissions (peak year - 1,000 tons)		
NO_x	0.63	2.99
CO	0.11	0.52
SO_x	0.09	0.38
VOC	0.02	0.09
TSP	0.00	0.01
New Onshore Facilities[6]		
Service Bases (number/acres)	-	2/50
Pipeline Landfalls (number)	1	3
Pipeline (miles constructed/acres)	-	60/720
Gas Processing Plants	-	1/60
Service Vessel Traffic[4]	1,500	10,400
Helicopter Traffic[4]	3,400	26,200
Oil Spill Estimates: Occurrences/Probability of Occurrence/Probability of Contact[7]		
Large Spills (≥1,000 bbls)	1/10/4	1/46/24
Medium Spills (50-999 bbls)	1/34/15	4/96/78
Small Spills (1-49 bbls)	16/99+/99+	99/99+/99+

[1] Estimates of oil and gas expected to be discovered and produced as a result of the proposed actions.

[2] Under the L Scenario, both oil and gas production occurs over the 20-year period, 1991-2010; peak oil production occurs from 1997-1999; and peak gas production occurs from 2000-2001. Under the H Scenario, both oil and gas production occurs over the 24-year period, 1988-2011; peak oil production occurs from 1994-1995; and peak gas production occurs from 1998-1999.

[3] Gathering and main pipelines.

[4] Number of trips (outbound plus inbound) for peak year activity.

[5] Total amount. Section IV.A.4.a. contains a detailed discussion on these discharges.

[6] The maximum number of new facilities expected to be established solely as a result of the proposed action, and the maximum amount of acreage expected to be used for these facilities. See Table IV-43 for location by coastal subarea.

[7] The assumed number of spill occurrences; the probability (expressed as percent chance) of one or more spills occurring; and the probability (expressed as percent chance) of one or more spills occurring and contacting land within 10 days. Spills are assumed to occur during the production periods indicated in footnote 2. The average size of a large spill is estimated at about 17 thousand bbls; the average medium spill is estimated at 154 bbls; and the average small spill is estimated at 4.2 bbls.

Table IV-42

Estimated Development Timetable for Offshore Infrastructure: Western Gulf Sale 112 - Low and High Find Scenarios

Year	Exploration and Delineation Wells Drilled		Platforms Installed		Development Wells Drilled		Pipeline Emplaced (miles)		Oil Production (million bbls)		Gas Production (bcf)	
	Scenario L	Scenario H	Scenario L	Scenario H	Scenario L	Scenario H	Scenario L	Scenario H	Scenario L	Scenario H	Scenario L	Scenario H
1987												
1988	6	15		1		10		6		0.5		6.7
1989	12	30		2		30		12		0.8		10.1
1990	15	40		3		50		18		5.0		16.8
1991	20	105	1	4	5	80	6	38	0.2	10.0	1.4	33.5
1992	15	70	1	5	10	80	6	30	0.4	12.5	5.6	67.0
1993	10	55	1	10	15	80	8	60	0.8	17.5	7.0	100.5
1994	5	40	2	5	20	50	12	44	1.6	22.5	14.0	134.0
1995	3	25	1	5	20	30	6	30	2.8	22.5	21.0	167.5
1996	2	15	1	3	15	25	6	18	3.6	20.5	35.0	234.5
1997	2	10	1	2	10	20	6	26	4.0	19.5	42.0	268.5
1998		5		1	5	20		6	4.0	18.0	56.0	301.5
1999				1		15		6	4.0	17.0	63.0	301.5
2000				1		10		6	3.6	15.5	70.0	268.0
2001						10			3.2	14.5	70.0	251.2
2002						10			2.8	11.2	63.0	217.8
2003									2.4	8.7	56.0	207.7
2004									2.0	8.0	49.0	194.3
2005									1.6	7.0	42.0	150.7
2006									1.2	5.5	35.0	117.3
2007									0.8	4.5	28.0	100.5
2008									0.5	3.0	21.0	83.7
2009									0.3	2.5	14.0	50.2
2010									0.2	2.0	7.0	40.2
2011										1.3		26.8
2012												
Total	90	410	8	43	100	520	50	300	40	250	700	3,350

Source: USDI, Minerals Management Service, Gulf of Mexico OCS Region estimates.

estimates. Production activity would occur over an estimated 20-year period under the L Scenario and over a 24-year period under the H Scenario.

Transportation assumptions for the L and H Scenarios are included in Table IV-41. All gas production and 70% of oil production is assumed to be pipelined to shore. The remaining 30% of oil production is assumed to be shuttle tankered to port terminal facilities in Texas and Louisiana.

New onshore facility use estimates are shown in Table IV-43. The estimated number of existing and new facilities used, compared to the M Scenario, is somewhat lower under the L Scenario (no new facilities would be needed) and somewhat higher under the H Scenario.

(2) Impact Analysis

The impact analyses in these subsections are written in a summary format. For more complete descriptions of impact causing factors, geographical locations, and impact discussions, refer to the same subsections in Section IV.D.2.a.

(a) Barrier Islands/Beaches

Low Find Scenario Impacts: In the WPA, it is estimated that the existing support infrastructure network is sufficient to handle the needs associated with this scenario. No additional pipeline landfalls or onshore pipelines are projected under this scenario. One oil spill (1,000 bbls or greater) and several smaller spills are assumed for analysis, and although the probability for contact is less than 5%, in the event a spill were to contact these areas, high to very high impacts could result. No ancillary facilities or new navigation canals are anticipated to result from this scenario; however, maintenance dredging of existing canals can be expected. As a result of the existing infrastructure handling proposed support needs and the extremely low potential for an oil spill to contact this resource, the expected impact to barrier beach habitats in coastal subareas W-1 and W-2 is estimated to be very low.

High Find Scenario Impacts: In the WPA, it is estimated that additional onshore infrastructure development, consisting of up to 3 pipeline landfalls and 60 miles of onshore pipeline is expected to result from this scenario. In coastal subarea W-1, up to 37 acres of barrier beach habitat could be altered, representing an alteration of less than 0.02% of this habitat type within the subarea. In addition, in coastal subarea W-2, up to 23 acres of barrier beach habitat could be altered, representing an alteration of less than 0.07% of this habitat type within the subarea. One oil spill (1,000 bbls or greater) is assumed in the analysis, and although the probability for contact is less than 20%, in the event a spill were to contact these areas, high to very high impacts could result. No ancillary facilities or new navigation canals are anticipated to result from this scenario; however, maintenance dredging of existing canals can be expected. As with the M Scenario, the expected impact to barrier beach habitats is very low in coastal subarea W-2 and low in W-1.

(b) Impacts on Wetlands

Low Find Scenario Impacts: In the WPA, no onshore construction is expected as a result of the low scenario. There is a 3% probability of one or more oil spills (1,000 bbls or greater) and several smaller spills occurring and contacting Galveston and Chambers Counties in Texas within 10 days of the spill. Galveston County has about 21 linear miles of wetlands that could be exposed to potential offshore oil spills; Chambers County has about 31 miles of exposed coastal wetlands. The barrier islands along this portion of the Texas coast would provide some protection to the wetlands behind the barrier islands. Based on the analysis of impacts, the projected level of impact is very low in coastal subarea W-1 and low in coastal subareas W-2 and C-1/C-2. In contrast, for the proposed action, Galveston and Chambers Counties have a 9% probability that one or more oil spills could occur and contact the wetlands in these areas.

High Find Scenario Impacts: In the WPA, onshore construction for the high scenario is estimated to be two service bases (one each in W-1 and W-2, each requiring about 25 acres), three pipelines (one in W-1 and two in W-2, each requiring about 20 acres), and one gas processing plant (in W-2, requiring about 60 acres). This onshore construction could result in destruction, alteration, or interference with up to 265 acres in subarea W-1 and 565 acres in W-2. This represents 0.05% of the wetlands in subarea W-1 and 0.12% in W-2. In contrast, for the proposed action, onshore construction is estimated at 265 acres in W-1 and W-2, representing 0.05% of the wetlands in W-1 and 0.06% in subarea W-2. It is unlikely that all of the onshore construction will occur in wetland areas; it is more

Table IV-43

Onshore Facility Use Assumptions:
Western Gulf Sale 112 - Low and High Find Scenarios

Facilities	L Scenario Existing	L Scenario New	H Scenario Existing	H Scenario New
Service Base	16	-	16	2[1]
Pipeline Installation Base	2	-	2	-
Pipe Coating Yard	2	-	3	0
Pipeline Landfall	3	-	5	3[2]
Onshore Pipeline (miles)	30	-	50	60[3]
Marine Terminal	1	-	5	-
Platform Fabrication Yard	2	-	6	-
Gas Processing Plant	2	-	7	1[4]
Refinery	1	-	3	-

The following notes indicate the range in the number of new facilities by coastal subarea, and likely potential locations in each subarea:

[1] 1 in W-1 and 1 in W-2: likely potential locations are the Port Mansfield, Ingleside-Port Aransas-Harbor Island, Rockport, and Port O'Connor areas in W-1;and the Freeport, Galveston-Pelican Island, and Sabine Pass areas in W-2.

[2] 2 in W-1 and 1 in W-2: potential locations include each of the coastal counties in subareas W-1 and W-2.

[3] 40 miles in W-1 and 20 miles in W-2: potential locations include each of the coastal counties in subareas W-1 and W-2.

[4] 1 in either W-1 or W-2: potential locations are Cameron, Willacy, Kenedy, Nueces, San Patricio, Aransas, and Calhoun Counties in W-1; and Matagorda, Brazoria, Galveston, Chambers, and Jefferson Counties in W-2.

probable the construction will occur in developed areas near existing infrastructure. The OSRA indicates a 16% probability of one or more spills (1,000 bbls or greater) and several smaller spills occurring and contacting Galveston and Chambers Counties in Texas within 10 days of the spill. In contrast, there is a 9% probability of an oil spill occurring and contacting Galveston and Chambers Counties (W-2) as a result of the proposed action. Based on the analysis of impacts, the estimated level of impact to wetlands for the high scenario is low in coastal subareas W-1 and C-1/C-2 and moderate in coastal subarea W-2.

(c) Impacts on Sensitive Offshore Habitats

Low Find Scenario Impacts

Proposed Action: Up to 90 exploration wells, 8 platforms, and 50 miles of pipelines may be expected as a result of this scenario. The biota of the topographic features would be subject to physical destruction from rig emplacement, platform and pipeline installation, and anchoring. The biota would also exhibit effects ranging from short-term stress responses to mortality resulting from the discharges associated with drilling. Because the numbers of wells and platforms are less in this scenario, the possibility of an operation occurring on or near a sensitive offshore habitat would be less than for the M Scenario. However, the impacts resulting from this scenario would be as severe as from the M Scenario. The expected level of impact from the low find scenario is very high.

Proposed Action with the Biological Stipulation: Up to 90 exploration wells, 8 platforms, and 50 miles of pipelines may be expected as a result of this scenario. Imposition of the biological stipulation would prevent these operations under routine conditions from adversely impacting the topographic features. The biological stipulation cannot prevent impacts resulting from accidental factors such as blowouts or seafloor oil spills. Because the numbers of wells and platforms in this scenario are less than the M Scenario, the probability of an accidental impact occurring would be even less than the M Scenario. The expected level of impact from the low find scenario with the biological stipulation is very low.

High Find Scenario Impacts

Proposed Action: Up to 410 exploration wells, 43 platforms, and 300 miles of pipelines may be expected as a result of this scenario. The biota of the topographic features would be subject to physical destruction from rig emplacement, platform and pipeline installation, and anchoring. The biota would also exhibit effects ranging from short-term stress responses to mortality resulting from the discharges associated with drilling. Because the numbers of wells and platforms are greater in this scenario, the possibility of an operation occurring on or near a sensitive offshore habitat would be greater than for the M Scenario. However, the impacts resulting from this scenario would be as severe as from the M Scenario. The expected level of impact from the high find scenario is very high.

Proposed Action with the Biological Stipulation: Up to 410 exploration wells, 43 platforms, and 300 miles of pipelines may be expected as a result of this scenario. Imposition of the biological stipulation would prevent these operations under routine conditions from adversely impacting the topographic features. The biological stipulation cannot prevent impacts resulting from accidental factors such as blowouts or seafloor oil spills. Because the numbers of wells and platforms in this scenario are greater than the M Scenario, the probability of an accidental impact occurring would be even greater than the M Scenario. The expected level of impact from the high find scenario with the biological stipulation is very low.

(d) Impacts on Water Quality

Low Find Scenario Impacts: Under this scenario, the discharge of up to 12.6 million bbls of formation waters, 0.86 million bbls of drilling muds, 97,090 yds^3 of drill cuttings, 7,000 bbls of sand from drilling operations, and an average of 33,600 gal/day of treated sanitary and domestic wastes from platforms may be expected. Pipeline-related activities would result in the disturbance of some 0.115-0.3 million yds^3 of sediment.

Offshore and nearshore waters will be subject to impacts from discharges of drilling fluids, formation waters, and other effluents which add burdens of both toxic and nontoxic materials to the water column. These quantities are far less than of those projected for the M Scenario; however, despite this, the natural processes of dispersion, degradation, and sedimentation will result in immeasurably low concentrations of these materials within a few meters to a few kilometers of the discharge sites, resulting in low impacts.

Point source discharges from existing onshore support facilities is estimated to be minimal with impacts to onshore water quality expected to be very low.

High Find Scenario Impacts: Under this scenario, the discharge of up to 225 million bbls of formation waters, 4.23 million bbls of drilling muds, 0.475 million yds^3 of drill cuttings, 125,000 bbls of sand from drilling operations, and an average of 180,600 gal/day of treated sanitary and domestic wastes from platforms may be expected. Pipeline-related activities would result in the disturbance of some 1.0-2.64 million yds^3 of sediment.

Offshore and nearshore waters will be subject to impacts from discharges of drilling fluids, formation waters, and other effluents which add burdens of both toxic and nontoxic materials to the water column. These activities are almost twice those projected for the M Scenario; however, the natural processes of dispersion, degradation, and sedimentation will result in immeasurably low concentrations of these materials within a few meters to a few kilometers of the discharge sites, resulting in low impacts.

Point source discharges from onshore support facilities and nonpoint source runoff from construction activities are estimated to be minimal with impacts to onshore water quality expected to be very low. These impacts may stem from the construction and operation of OCS onshore support facilities consisting of up to one new gas processing plant, 60 miles of onshore pipelines, 4 new pipeline landfalls, and up to 2 service bases projected for the WPA.

(e) Impacts on Air Quality

Low Find Scenario Impacts: Estimates for the WPA include no new gas processing plants and no new or expanded refineries needed. Under the M Scenario, no new refineries and two gas processing plants are projected. It is expected that up to 90 exploratory and delineation wells, 100 development/production wells, and 8 platforms will be utilized. This compares to 215 exploratory and delineation wells, 276 development wells, and 23 platforms projected for the M Scenario. New activity is expected to be almost evenly distributed throughout the WPA with subplanning area W-2 having the most expected activity. The overall impact on coastal air quality is expected to be low in any nearby coastal area where an uncontrolled sour gas blowout occurs. Low impacts are expected in Cameron, Nueces, Galveston, Jefferson, and Brazoria Counties in Texas. Very low impacts are expected throughout the remainder of the coastal area of the Western Gulf.

High Find Scenario Impacts: It is expected that up to 410 exploratory and delineation wells, 520 development/production wells, and 43 platforms will be utilized, along with 2 gas processing plants and no refineries. This compares to 215 exploratory and delineation wells, 276 development wells, 23 platforms, 2 gas processing plants, and no refineries. New activity is expected to be almost evenly distributed throughout the WPA with subplanning area W-2 having the most expected activity. The overall impact on coastal air quality is expected to be low to moderate in any nearby coastal area where an uncontrolled sour gas blowout occurs. Low impacts are expected in Cameron, Nueces, Galveston, Jefferson, and Brazoria Counties in Texas. Very low impacts are expected throughout the remainder of the coastal area of the Western Gulf.

(f) Impacts on Endangered and Threatened Species

The impact analyses in this subsection are written in a summary format. For a more complete description of impact causing factors and geographical locations, and an impact discussion, refer to the same subsection heads in Section IV.D.2.a.(5).

Low Find Scenario Impacts

Brown Pelicans: There is less than a 0.5% probability of one or more spills (greater than 1,000 bbls) occurring and contacting brown pelican feeding/nesting habitat along the southwestern Texas coast (subarea W-1) (Table IV-20). It is unlikely that oil spills occurring as a result of the low scenario would have an adverse impact on brown pelicans along the Western Gulf coast. In contrast, there is less than a 0.5%-3% probability of one or more oil spills occurring and contacting brown pelican feeding/nesting habitat in subarea W-2 (southwestern Texas) for the proposed action.

Offshore-related aircraft and vessel traffic in the Western Gulf is not expected to increase as a result of the low scenario. In contrast, aircraft and vessel traffic near brown pelican feeding/nesting habitat may increase about 2% in the WPA as a result of the proposed action.

No onshore facility construction is expected to occur in the WPA as a result of the low scenario. In contrast, onshore construction for the proposed action is estimated at two service bases and two pipelines requiring about 242 acres in both subareas W-1 and W-2.

A very low level of impact on brown pelicans from potential offshore-related oil spills, aircraft/vessel traffic, and coastal construction is expected in the WPA as a result of the low scenario and very low as a result of the proposed action.

Marine Mammals (Whales): There is less than a 5% probability of one or more oil spills occurring and contacting deepwater areas where whales occur in the WPA. It is unlikely that OCS-related oil spills will affect whales in the WPA as a result of the low scenario. In contrast, there is less than a 10% probability of an oil spill occurring and contacting whales as a result of the proposed action.

Vessel traffic in the WPA is estimated not to increase as a result of the low scenario. In contrast, for the proposed action, vessel traffic in the WPA could increase about 2%. The level of vessel collisions with whales in the WPA is unknown; no injuries or mortalities resulting from offshore oil/gas-related activities have been reported or documented in the WPA.

About 90 exploration and delineation wells will be drilled and some additional seismic exploration will be required as a result of the low scenario. The effect of this disturbance to whales is unknown; however, because it is usually short-term and fairly localized, it is unlikely to cause a major impact on whales in the WPA as a result of the low scenario. In contrast, for the proposed action, 216 wells may be drilled and additional seismic activity may be required.

It is expected that offshore oil/gas-related oil spills, collisions with offshore vessel traffic, and disturbance from offshore oil/gas activities will have a very low level of impact on whales in the Western Gulf as a result of the low scenario and very low as a result of the proposed action.

Sea Turtles: For the low scenario there is less than a 0.5% probability of one or more OCS-related oil spills (greater than 1,000 bbls) occurring and contacting sea turtles nesting beaches along the southwestern Texas coast. For the proposed action there is a negligible probability (less than 1%) of an oil spill occurring and contacting a turtle nesting beach along the southwestern Texas coast. Oil spills drifting offshore could have a deleterious effect on sea turtles when they are basking on the surface or surface to breathe.

Offshore vessel traffic in the WPA is estimated not to increase as a result of the low scenario. In contrast, offshore vessel traffic in the WPA is estimated to increase about 2% for the proposed action. The level of vessel collisions with sea turtles in the WPA is unknown; no injuries or mortalities have been reported or documented.

No pipeline or service facility construction is expected to occur in the WPA as a result of the low scenario. In contrast, for the proposed action, there are 2 pipelines, 40 miles of onshore pipeline, and 2 service bases (Table IV-1).

A very low level of impact on sea turtles from offshore-related oil spills and collisions with offshore support vessels is expected in this area as a result of the low scenario, and a low level of impact is estimated for the proposed action.

High Find Scenario Impacts

Brown Pelicans: There is a 1% probability of one or more spills (greater than 1,000 bbls) occurring and contacting brown pelican feeding/nesting habitat along the southwestern Texas coast (subarea W-2). In contrast, there is a 1% probability of an oil spill occurring and contacting brown pelican habitat in southwestern Texas as a result of the proposed action. It is unlikely that oil spills would have an adverse impact on brown pelicans along the southwestern Texas coast as a result of the high scenario.

The brown pelican is susceptible to noise disturbance and habitat alteration of nesting areas which may cause nest desertion and egg losses. Aircraft and vessel traffic in the Western Gulf is estimated to increase less than 5%. In contrast, vessel traffic in the WPA is estimated to increase about 2% for the proposed action.

It is estimated that 2 service bases, 1 gas processing plant, 3 pipelines, and 60 miles of onshore pipeline may be required in the WPA as a result of the high scenario. It is unlikely this onshore construction would impact brown pelican nesting and feeding habitat in the southwestern coastal area of Texas. In contrast, there is one less pipeline and no gas processing plant in subarea W-2 (45 fewer acres) estimated for the proposed action.

A low level of impact on brown pelicans from offshore oil/gas-related oil spills, aircraft/vessel traffic, and coastal construction is expected in the Western Gulf as a result of the high scenario. In contrast, a very low level of impact on brown pelicans is estimated for the proposed action.

Marine Mammals (Whales): There is less than a 15% probability of one or more oil spills occurring and contacting deepwater areas where whales occur in the WPA. It is unlikely that these oil spills will affect whales in the WPA. In contrast, there is less than a 10% probability of an oil spill occurring and contacting deepwater areas where the majority of whales occur in the WPA.

Vessel traffic in the WPA is estimated to increase less than 5% as a result of the high scenario. The level of vessel collisions with whales in the WPA is unknown; no injuries or mortalities resulting from offshore oil/gas-related activities have been reported or documented. In contrast, for the proposed action, vessel traffic is estimated to increase about 2% in both subareas W-1 and W-2.

About 410 exploration and delineation wells will be drilled, and additional seismic exploration will be required as a result of the high scenario. The effect of this disturbance to whales is unknown; however, because it is usually short-term and fairly localized, it is unlikely to cause a major impact on whales in the WPA as a result of the high scenario. In contrast, for the proposed action, about 216 exploration and delineation wells are estimated with about a 50% reduction in seismic activity over the same time period.

It is expected that offshore oil/gas-related oil spills, collisions with offshore-related vessel traffic, and disturbance from offshore-related oil/gas activities will have a very low level of impact on whales in the Western Gulf as a result of the high scenario and a very low level of impact for the proposed action.

Sea Turtles: There is about a 1% probability of one or more offshore oil/gas-related oil spills (greater than 1,000 bbls) occurring and contacting sea turtles nesting beaches along the southwestern Texas coast. With this very low incidence of occurrence, it is unlikely the high scenario would have an adverse impact on sea turtles nesting along the subarea W-2 coast. In contrast, for the proposed action, there is less than a 0.5% probability of an offshore oil spill contacting sea turtle nesting beaches in subarea W-2. Oil spills drifting offshore could have a deleterious effect on sea turtles when they surface to breathe or could contaminate food sources.

Offshore oil/gas-related vessel traffic in the WPA is estimated to increase less than 5%. In contrast, for the proposed action, vessel traffic is estimated to increase about 2%. The level of vessel collisions with sea turtles in the WPA is unknown; no injuries or mortalities have been reported or documented.

Two service bases, one gas processing plant, and three pipelines may be required in the WPA as a result of the high scenario. In contrast, for the proposed action, there is one less pipeline and no gas processing plant estimated for subarea W-2. It is unlikely any of this onshore construction will occur on a sea turtle nesting beach in the WPA.

A low level of impact on sea turtles from potential offshore oil/gas-related oil spills, collisions with offshore-related support vessels, and pipeline construction is expected in this area as a result of the high scenario, and a low level of impact is estimated for the proposed action.

(g) Impacts on Coastal and Marine Birds

Low Find Scenario Impacts: The highest probability (3%) of one or more oil spills (greater than 1,000 bbls) occurring and contacting coastal and marine bird habitat in the WPA is in Galveston County. Considering the low possibility of offshore oil spills in this area, it is unlikely that coastal and marine birds in the WPA will be affected by oil spills as a result of the low scenario. In contrast, for the proposed action, there is a 9% probability of an oil spill occurring and contacting coastal and marine bird habitat in Galveston County, Texas.

Disturbance of coastal and marine birds nesting and feeding habitat from onshore construction and associated noise from air and vessel traffic could result in a reduction or elimination of birds that use the habitat for feeding or nesting. Dredging and the construction of pipelines and roads could change water flows that may result in the alteration or destruction of coastal feeding/nesting areas.

No onshore construction is expected to occur in the WPA as a result of the low scenario. In contrast, for the proposed action, two service bases and two pipelines are estimated for WPA, one each in subareas W-1 and W-2.

A very low level of impact on coastal and marine birds from offshore-related oil spills and disturbance from air and vessel traffic is expected in the WPA as a result of the low scenario, and a very low level of impact is estimated for the proposed action.

High Find Scenario Impacts: The highest probability (16%) of one or more spills (greater than 1,000 bbls) occurring and contacting coastal and marine bird habitat in the WPA is in Galveston County. It is likely that offshore-related oil spills will have a low impact on coastal and marine birds in the WPA. In contrast, for the proposed action, there is a 9% probability of an oil spill occurring and contacting coastal and marine bird habitat in Galveston County, Texas.

Disturbance of coastal and marine birds nesting and feeding habitat from onshore construction and associated noise from air and vessel traffic could result in a reduction or elimination of birds that use the habitat for feeding or nesting. Dredging and the construction of pipelines and roads could change water flows that may result in the complete conversion of the wetland ecosystem and loss of feeding/nesting habitat.

It is estimated that 2 service bases, 1 gas processing plant, 4 pipelines, and up to 60 miles of onshore pipeline may be required in the WPA as a result the high scenario. In contrast, for the proposed action, there is one less pipeline and no gas processing plant estimated to be constructed in subarea W-2. This onshore construction could impact coastal and marine bird feeding and nesting habitat if it is located in undeveloped areas near coastal/marine bird habitat.

A low level of impact on coastal and marine birds from potential offshore-related oil spills and disturbance from onshore construction is expected in the WPA as a result of the high scenario, and a very low level of impact is estimated for the proposed action.

(h) Impacts on the Commercial Fishing Industry

Low Find Scenario Impacts: Eight offshore platforms/structures are expected in the WPA, eliminating less than 0.1% (24-40 acres) of trawling area. Of these eight offshore platforms/structures, two are expected for subplanning area W-1, five for W-2, and one for W-3. Fishermen would absorb some economic loss through gear conflicts. The probability of one or more large spill (1,000 bbls) occurrences and contacts is 4%. The probability of these spills contacting the Galveston Bay system which contains finfish and shellfish nursery and/or spawning grounds is very low, less than 0.5% (Table IV-40). A very low impact is expected on the commercial fishing industry.

High Find Scenario Impacts: Forty-three offshore platforms/structures are expected in the WPA, eliminating less than 0.1% (129-215 acres) of trawling area. Of these 43 offshore platforms/structures, 11 are expected for subplanning area W-1, 26 for W-2, and 6 for W-3. The probability of one or more large spill (1,000 bbls) occurrences and contacts is 25%. The probability of these spills contacting the Galveston Bay system which contains finfish and shellfish nursery and/or spawning grounds is 16% (Table IV-40). A spill contacting the Galveston Bay system could result in severe medium-term (1-3 years in duration) consequences on invertebrates and vertebrate fisheries and could deter fishing.

A high impact is expected on the commercial fishing industry.

(i) Impacts on Major Shorefront Recreational Beaches

Low Find Scenario Impacts: Under the low find scenario, a total of 190 wells are expected to be drilled over a 10-year period resulting in the installation of 8 new platforms offshore Texas and the production of 40 million bbls of oil (Table IV-42). Under the most likely find scenario, 728 wells will be drilled, 34 production platforms installed, and 130 million bbls of oil produced. The low find scenario will lead to approximately one-fourth the offshore activity and one-third the oil production associated with the most likely find scenario; therefore, the potential for oil spills and trash loss will be significantly decreased from the most likely find scenario resulting from the proposed action. No major spills are likely to occur and contact recreational beaches (4% chance) under the proposed action (L Scenario); therefore, there would be little, if any, adverse impact to shorefront recreational beaches from oil pollution. Some debris and trash associated with exploratory, development, and production operations may wash upon recreational beaches. The expected impacts would be low.

High Find Scenario Impacts: Under the high find scenario, 930 wells are expected to be drilled over a 14-year period (1987-2001) resulting in the installation of 43 new platforms offshore Texas and the production of 250 million bbls of oil (Table IV-42). Under the most likely find scenario, 728 wells will be drilled, 34 production platforms installed, and 130 million bbls of oil produced. The high find scenario will lead to approximately 15% more offshore activity and twice the oil production associated with the most likely find scenario; therefore, the potential for oil spills will about double but the increment in trash loss is likely to be significant from that associated with the most likely find scenario resulting from the proposed action. Analysis indicates there is a reasonably foreseeable potential for one major oil spill contact (22% chance) to occur in the WPA and contact a major shorefront recreational beach under the high find scenario (Table IV-20). Galveston Island's recreational beaches are most likely to be adversley affected (16% chance) from oil pollution associated with the proposed action. Debris and trash associated with offshore operations is likely to cause intermittent aesthetics and maintenance problems on Texas beaches. The expected impacts would be low to moderate on affected beaches.

(j) Impacts on Archaeological Resources

Low Find Scenario Impacts

Historic: The lower level of offshore development projected for the low find scenario would reduce the potential for an interaction between an impact producing factor and an historic shipwreck. Should an interaction occur, the potential exists for the loss of significant or unique archaeological information. The resulting impact would be high to very high.

The archaeological stipulation, if adopted, would reduce the potential for an interaction between an impact producing factor and an historic shipwreck by 25%-30% in the western portion of the WPA. This would not significantly reduce the potential for an interaction; therefore, in the western portion of the WPA, there would still be potential for a high to very high impact. In the eastern portion of the WPA, the potential for an interaction would be reduced by 90%. This is a sufficient reduction in probability that it can be assumed that little damaging interaction between an impact producing factor and an archaeological site would occur. Therefore, the stipulation would reduce the potential impact to historic shipwrecks in the eastern portion of the WPA from very high to very low.

No new onshore facilities are projected for the WPA under the low find scenario; therefore, no impact to onshore historic sites is expected.

Should an oil spill contact a coastal historic site such as a fort or lighthouse, the major impact would be visual due to oil contamination of the site and its environment. This impact would probably be temporary and reversible with no actual loss of information. Under the low find scenario the probability of a large spill contact (1,000 bbls or greater) is low (a 2% chance, Table IV-20). Based on the criteria of significance outlined above, the expected impact to coastal historic sites from an oil spill would be very low.

Prehistoric: The lower level of offshore development projected for the low find scenario would reduce the potential for an interaction between an impact producing factor and a prehistoric site. Should an interaction occur, the potential exists for the loss of significant or unique archaeological information. The resulting impact would be high to very high.

The archaeological stipulation, if adopted, would reduce the potential for an interaction between an impact producing factor and a prehistoric archaeological site by about 90%. This is a sufficient reduction in probability that it can be assumed that little damaging interaction between an impact producing factor and an archaeological site would occur. Therefore, the stipulation would reduce the potential impact to prehistoric sites in the WPA from very high to very low.

No new onshore facilities are projected for the WPA under the low find scenario; therefore, no impact to onshore historic sites is expected.

Should an oil spill contact a coastal prehistoric site, the potential for dating the site using Carbon-14 would be destroyed. However, if diagnostic artifacts are present in the site, loss of C-14 dating potential may not constitute a loss of unique information.

Previously unrecorded coastal sites may suffer direct physical impact from beach cleanup operations. Interaction of cleanup equipment with a site could destroy fragile artifacts or site features and could disturb the site context. The result would be the loss of information on the prehistory of North America and the Gulf Coast Region. Of the coastal prehistoric sites that may be impacted by beach cleanup operations, some may contain unique information; however, the probability of a major spill contact is low (a 2% chance, Table IV-20). Therefore, the expected impact to coastal prehistoric sites from an oil spill would be very low.

High Find Scenario Impacts

Historic: The higher level of offshore development projected for the high find scenario would increase the potential for an interaction between an impact producing factor and an historic shipwreck. Should an interaction occur, the potential exists for the loss of significant or unique archaeological information. The resulting impact would be high to very high.

The archaeological stipulation, if adopted, would reduce the potential for an interaction between an impact producing factor and an historic shipwreck by 25%-30% in the western portion of the WPA. This would not significantly reduce the potential for an interaction; therefore, in the western portion of the WPA, there would still be potential for a high to very high impact. In the eastern portion of the WPA, the potential for an interaction would be reduced by 90%. This is a sufficient reduction in probability that it can be assumed that little damaging interaction between an impact producing factor and an archaeological site would occur. Therefore, the stipulation would reduce the potential impact to historic shipwrecks in the eastern portion of the WPA from very high to very low.

Under the high find scenario the number of acres projected for disturbance from new onshore facilities in the WPA is 830 acres. Due to the low amount of acreage projected for disturbance, the visibility of most onshore historic sites, and State and Federal archaeological laws which require consideration of historic properties if any State or Federal funding or permits are required for construction, the expected impact to coastal historic sites in the WPA as a result of the projected onshore development associated with the high find scenario is very low.

Should an oil spill contact a coastal historic site such as a fort or a lighthouse, the major impact would be visual due to oil contamination of the site and its environment. This impact would probably be temporary and reversible with no actual loss of information. Under the high find scenario the probability of a large spill contact (1,000 bbls or greater) is moderate (an 11% chance, Table IV-20). Based on the criteria of significance outlined above, the expected impact to coastal historic sites from an oil spill would be low.

Prehistoric: The higher level of offshore development projected for the high find scenario would increase the potential for an interaction between an impact producing factor and a prehistoric site. Should an interaction occur, the potential exists for the loss of significant or unique archaeological information. The resulting impact would be high to very high.

The archaeological stipulation, if adopted, would reduce the potential for an interaction between an impact producing factor and a prehistoric archaeological site by about 90%. This is a sufficient reduction in probability that it can be assumed that little damaging interaction between an impact producing factor and an archaeological site would occur. Therefore, the stipulation would reduce the potential impact to prehistoric sites in the WPA from very high to very low.

Under the high find scenario the number of acres projected for disturbance from new onshore facilities in the WPA is 830 acres. Due to the low amount of acreage projected for disturbance and State and Federal archaeological laws which require consideration of archaeological properties if any State or Federal funding or permits are required for construction, the expected impact to coastal prehistoric sites in the WPA as a result of the projected onshore development associated with the high find scenario is very low.

Should an oil spill contact a coastal prehistoric site, the potential for dating the site using Carbon-14 would be destroyed. However, if diagnostic artifacts are present in the site, loss of C-14 dating potential may not constitute a loss of unique information.

Previously unrecorded coastal sites may suffer direct physical impact from beach cleanup operations. Interaction of cleanup equipment with a site could destroy fragile artifacts or site features and could disturb the site context. The result would be the loss of information on the prehistory of North America and the Gulf Coast Region. Of the coastal prehistoric sites that may be impacted by beach cleanup operations, some may contain unique information. The probability of a major spill contact is moderate (an 11% chance, Table IV-20). Therefore, there is potential for a high to very high impact to coastal prehistoric sites from an oil spill under the high find scenario.

e. Unavoidable Adverse Impacts of the Proposed Action

Wetlands: There is a chance that one or more spills greater than 1,000 bbls could occur and contact land within 10 days over the production life of the proposed action. If an oil spill does contact coastal wetlands, adverse environmental impacts could be high. Oil contamination could kill an undetermined amount of coastal wetlands. The adverse effects of oil on coastal wetlands would be relatively long-term (1-3 years).

Construction of new pipelines/infrastructure is expected to damage or destroy up to 37 acres of wetlands in subarea W-1 and up to 241 acres in subarea W-2. A pipeline in subarea W-1 could damage or destroy up to 12 acres of seagrasses.

Sensitive Offshore Habitats: Severe and perhaps permanent damage to the biota of the topographic features would result if a blowout or seafloor oil spill were to occur in proximity to a topographic feature. Low relief topographic features would experience increased sedimentation and turbidity from the unshunted drill discharge. In addition, the proposed action, without the biological stipulation, would result in potentially permanent destruction of the productive biological habitats of the topographic features.

Water Quality: Normal offshore operations would have unavoidable effects to varying degrees on the quality of the surrounding water if the proposed action is implemented. Drilling, construction, and pipelaying would cause an increase in the turbidity of the affected waters for the duration of the activity periods, and, in the case of pipelines, could disturb settled pollutants. A turbidity plume, several hundred yards in length, could also be created by discharge of drill cuttings and the adherent drilling fluids. This, however, would only affect water in the immediate vicinity of the rigs. The discharge of treated sewage from the rigs and platforms would increase the levels of suspended solids, nutrients, chlorine, and BOD in a small area near the discharge points. Chronic spills from platforms and the discharge of formation waters will result in increases of hydrocarbon levels and possibly trace metal concentrations in the water column. Overall, the effect will be the degradation of water quality around platforms, although the extent of the impact will extend only from a few meters to a few tens of meters from the platform site. Unavoidable impacts to onshore water quality will also occur as a result of runoff from construction sites of new facilities, but these impacts will be localized in the vicinity of these sites, and of limited duration. Some additional impacts will accrue from increased sewage due to population growth in certain communities. Regulatory requirements of State water authorities (under Federal and State regulations and guidelines) and some local jurisdictions would be applicable to most, if not all, of these potential impact situations. Therefore, the opportunity would exist to effectively mitigate potential impacts if the applicable regulatory measures were strictly enforced.

Air Quality: Unavoidable adverse impacts to air quality would occur onshore adjacent to crude oil refineries, gas processing plants and areas of concentrated OCS activities. Unavoidable short-term impacts to air quality would occur near catastrophic events (oil spills, blowouts with fire, blowouts without fire) due to evaporation and combustion. Mitigation of long-term effects will be accomplished through existing regulations. However, short-term effects from nonroutine catastrophic events (accidents) are uncontrollable.

Endangered and Threatened Species: OCS-related oil/gas vessel traffic in the Western Gulf could result in some collision injuries to marine turtles. Oil spills could result in some injury or mortality to marine turtles and brown pelicans. Some injury or mortality to endangered whales could result from OCS-related oil spills, collision with offshore support vessels, and/or seismic activities.

Coastal and Marine Birds: Some injury or mortality to individual and/or local populations of coastal and marine birds could result from OCS-related oil spills.

Commercial Fishing Industry: Of the various types of fishing gear in use in the OCS areas, trawls have the greatest chance for operational conflicts with oil and gas activities. Losses may, however, be compensated under the Fishermen's Contingency Fund or other legal routes. Trawl nets can be snagged on underwater stubs causing damage or loss of the nets. In addition, it is conceivable that snags could damage underwater production equipment or pipelines causing a spill of oil and gas. Because safety equipment is installed, which shuts in production when a loss of pressure occurs, the likelihood of a major spill resulting thereby is considered very small. Less frequently, large objects which were lost overboard from petroleum industry boats, pipeline lay barges, and platforms are caught by fishing gear resulting in damage to the gear and/or its catch of fish; however, occurrence of this type of incident is low. Also, commercial fishermen would probably not harvest fish in the area of an oil spill, as spilled oil could coat or contaminate commercial fish species rendering them unmarketable. Other unavoidable adverse impacts include loss of fish space caused by installation of unburied pipelines, rigs, platforms, or by other OCS-related structures. There may be some localized competition for shore facilities.

Major Shorefront Recreational Beaches: Even though existing regulations and OCS orders prohibit indiscriminate littering of the marine environment with trash, offshore oil and gas operations involving men, machines, equipment, and supplies is bound to result in some littering of the ocean. Human nature and accidents associated with offshore operations will contribute some floatable debris to the ocean environment which will eventually come ashore on major recreational beaches. Likewise, accidents can lead to oil spills which are difficult to contain in the ocean; therefore, it may be unavoidable that some recreational beaches become temporarily soiled by weathered crude oil.

Archaeological Resources: As a result of the proposed action, unique or significant archaeological information may be lost. The lease stipulation would significantly lower the potential for this loss occurring by identifying potential archaeological sites prior to lease development, thereby making avoidance or mitigation of impacts possible.

Military Use/Warning Areas: In this planning area the trips of helicopters and service boats, and the location and number of exploration rigs and production structures will produce unavoidable adverse impacts on military use of the warning areas to the extent that military missions could be curtailed or shifted to another location within a warning area. In particular, this is an increasing concern within W-228, where the impacts could significantly influence military training and testing to the extent that they jeopardize the lives of military personnel and/or oil- and gas-related personnel working in the areas. Continued cooperation between industry, the Navy, and the USAF should prevent the loss of life and equipment to industry helicopters and service vessel traffic crossing an intensively used warning area. Continued flexibility in operations by the Navy and USAF should help to maintain multiple use of the warning areas.

Ports and Marine Transportation: A certain amount of interference between vessel traffic and offshore structures will occur as a result of the proposed action. This could lead to an increase in accidents involving OCS vessels and structures. Most foreign flag vessels and others who may be unaware of the locations of structures in an area will generally use the extensive network of safety fairways, which provide clear passage 2 nmi in width through the developed areas of the Gulf (Section I.B.4.a.). Those more familiar with an area may choose not to use the fairways. Coast Guard regulations regarding structure safety lights and horns, and ship safety regulations are important factors in minimizing conflicts and preventing accidents between structures and vessels on the OCS. However, with vessel operations at night, in rough water, or in fog, the potential for accidents increases.

f. Irreversible and Irretrievable Commitment of Resources

Wetlands: An irreversible and irretrievable commitment of biological resources could occur where wetlands are impacted by frequent oil spills and chronic low level contamination with oil. Repeated contact with oil will destroy wetlands vegetation which results in soil erosion and land loss. Animals killed by oil spills constitute a permanent loss of coastal biota.

Construction and emplacement of infrastructures and pipelines in wetlands can result in the permanent loss of coastal wetlands due to mechanical destruction of plants and animals and due to land loss facilitated by saltwater intrusion followed by erosion of marsh soils.

Sensitive Offshore Habitats: An irreversible and irretrievable commitment of biotic resources could occur in areas subjected to intensive development, particularly at the East and West Flower Garden Banks. Oil spills and chronic low level pollution can injure and kill organisms at virtually all trophic levels. Mortality of individual organisms can be expected to occur, and possibly reduction or even elimination of a few small or isolated populations. The magnitude of these effects is nearly impossible to predict; Section IV.D.2.a.(2) identifies the types of impacts which can occur and the resources which are particularly sensitive to adverse impacts resulting from the proposed action. Adverse impacts resulting from the proposed action, without the biological stipulation, are expected to be very high and potentially permanent.

Archaeological Resources: Although the expected impact to archaeological resources as a result of the proposed action is uncertain, any interaction between an impact producing factor (drilling of exploratory, delineation, and development wells, placement of platforms, subsea completions, and pipeline installation) and a significant historic shipwreck or prehistoric site would destroy information contained in the site components and in their spatial distribution. This would be an irretrievable commitment of potentially unique archaeological data.

Local Employment, Income, and Population: The proposed action would result in the production of certain OCS-related goods and services. To the extent that resources would be drawn away from other uses, production of goods and services in other areas of other types would be foregone. Steel products, specialized manpower, and capital constitute required resources which may be scarce; use of these resources for OCS needs means that other opportunities for their use might have to be foregone. While these resources may be reclaimed over time, their use as a result of the proposed action would constitute an irreversible and irretrievable commitment of resources at a given point in time. To the extent that underemployed labor resources are used to fill new job opportunities, this would not constitute a cost to society in the form of foregone labor opportunities.

Oil and Gas Development: Leasing of the proposed blocks and subsequent development and extraction would represent an irreversible and irretrievable commitment of nonrenewable oil and gas resources. The estimated amount of resources expected to be recovered as a result of proposed lease Sale 112 is presented in Table IV-1.

Loss of Human and Animal Life: OCS oil and gas exploration, development, production, and transportation is carried out under comprehensive, state-of-the-art, enforced regulatory procedures designed to ensure public safety and environmental protection. Notwithstanding, some loss of human and animal life is inevitable from unpredictable and unexpected acts of man and nature (adverse weather conditions, unavoidable accidents, human error, and noncompliance). Some normal and required operations such as platform removal will result in the destruction of viable marine communities. Although individual organisms and fish will die, there is unlikely to be a lasting effect on baseline marine populations.

g. Relationship Between the Short-term Use of Man's Environment and the Maintenance and Enhancement of Long-term Productivity

The principal short-term use of the leased areas in the Gulf under the proposals would be for the production of an estimated 0.13 billion bbls of oil and an estimated 1.87 tcf of natural gas.

This activity would temporarily interfere with recreation and tourism in the region in the event of a major oil spill (1,000 bbls or more) contacting popular tourist beaches. The probability of such an occurrence within a 10-day period after a spill is 12%.

The short-term recovery of hydrocarbons may have long-term impacts on offshore biologically sensitive areas (Sections IV.D.1.a.(2) and IV.D.2.a.(2)) or archaeological resources (Sections IV.D.1.a.(9) and IV.D.2.a.(9)).

The proposed leasing may also result in onshore development and population increases which may cause very short-term adverse impacts to local community infrastructure, particularly in areas of low population and minimal existing industrial infrastructure. However, these impacts will occur only in the very short term. A return to equilibrium can be quickly expected as population changes and industrial development are absorbed in expanded communities.

After the completion of oil and gas production, oil spills and their impacts will not occur, and the marine environment is generally expected to remain at or return to its normal long-term productivity levels. It has been recognized that continuous, low-level pollution from toxic chemicals, including oil, may adversely affect long-term ocean productivity. However, to date there has been no discernible decrease in long-term marine productivity in OCS areas where oil and gas have been produced for many years. In other areas which have experienced apparent increases in oil pollution, such as the North Sea, some long-term effects appear to have taken place. Populations of pelagic birds have decreased markedly in the North Sea in recent years--prior to the beginning of North Sea oil production. Until more reliable data become available, the long-term effects of the chronic and major spillage of hydrocarbons and other drilling related discharges cannot be accurately projected. In the absence of such data, it must be concluded that the possibility of decreased long-term productivity exists as a result of the proposed action. It is possible that such high value areas as the Flower Garden Banks will suffer long-term losses as a result of this proposed action.

OCS development off Louisiana and Texas has supported recreational and commercial fishing activities. This has stimulated the manufacture and sale of larger private fishing vessels and special fishing and recreational equipment. Additionally, commercial enterprises such as charter boats have become heavily dependent on offshore structures for satisfying recreational customers. This proposed action will increase these incidental benefits of offshore development. The platforms expected to result from the proposed action will help replace those currently being removed where production has terminated. As the incidence of offshore fishing and diving has gradually increased in the past three decades, platforms (the focus of much of that activity) will eventually begin to gradually decline as mineral resources become depleted. In order to maintain the long-term productivity of site-specific, artificial locations attractive to fishermen and divers, some means, such as proliferation of artificial reef development programs, will need to eventually replace platform removals.

In summary, short-term environmental socioeconomic impacts may result from the proposed action, including possible short-term losses in productivity as a result of oil spills. Long-term adverse environmental impacts are not expected if the archaeological and biological stipulations are adopted as part of the proposed action. However, some risk remains due to the potential for accidents. Oil and gas reserves would be lowered. Few long-term productivity or environmental gains are expected as a result of this proposed action; the benefits of the proposed action are expected to be principally those associated with a medium-term increase in supplies of domestic oil and gas. While no reliable data exist to indicate long-term productivity losses as a result of OCS development, such losses are possible. However, to the extent that OCS development would replace imports of oil which would otherwise be required, such losses as a result of tanker-related oil spills may occur in the absence of this proposed action.

SECTION V

CONSULTATION AND COORDINATION

V

V. CONSULTATION AND COORDINATION

A. DEVELOPMENT OF THE PROPOSED ACTIONS

Central Gulf of Mexico OCS Lease Sale 110 (April 1987) from the Department of the Interior's Final 5-Year OCS Oil and Gas Leasing Schedule (July 1982) and Western Gulf of Mexico OCS Lease Sale 112 (August 1987) from the Proposed 5-Year OCS Oil and Gas Leasing Program (announced February 1986) are considered separate proposals. The Area Identification (AI) process for these sales was initiated on June 24, 1985, with the *Federal Register* publication of the Call for Information and Nominations (Call) and Notice of Intent to Prepare an EIS (NOI). Copies of the Call/NOI were mailed to the Governors of the affected states, State and Federal agencies, industry, environmental groups, and interested individuals.

The Call identified the CPA and WPA (approximately 80 million acres) as having the potential for the discovery of hydrocarbons. Respondents were asked to delineate areas of potential interest within the Call areas and to rank those areas according to priority of interest. The NOI requested information on the scope of the EIS, significant issues which could be addressed, and alternatives which should be considered.

Based on responses to the Call (summarized below), DOI identified the area to be analyzed in the Draft EIS for proposed Sales 110 and 112. This action constituted the official AI which was administratively approved on October 7, 1985. The area to be studied included approximately 31.4 million unleased acres in the Central Gulf and approximately 27.3 million unleased acres in the Western Gulf for a total of approximately 88.7 million acres. Two environmentally sensitive blocks (Blocks A-375 and A-389 in High Island Area, East Addition, South Extension) which contain the living coral reefs of the East and West Flower Garden Banks and 123 blocks (located in South Padre Island Area and South Padre Island Area, East Extension) along the provisional United States maritime boundary with Mexico were deferred from Sale 112 in the Western Gulf. No deferrals were proposed for Sale 110 in the Central Gulf.

B. DEVELOPMENT OF THE DRAFT EIS

In order to fulfill OCSLA (as amended) requirements and CEQ regulations, MMS followed scoping procedures for contacting and coordinating with Federal, State, and local governments, institutions, public interest groups, and concerned individuals throughout the development of this document. There were five major steps in this process:

(1) The Call/NOI publication and mailout which provided information for the AI as discussed above.

(2) Letters to the Governor's of the affected states which provided an announcement of the issuance of the Call/NOI and provided information required by Section 8(g) of the OCSLA.

(3) Requests for resource information were mailed to the states, appropriate Federal agencies, and industry in August 1985. This involved requests for specific technical information and for updated information from agencies which had jurisdiction or special expertise with respect to possible environmental impacts resulting from the lease sales or with authorization to develop and enforce environmental standards to mitigate such impacts.

(4) Following the AI decision on October 3, 1985, additional scoping letters were sent to the Governors announcing the results of the AI. These further solicited comments and recommendations on potential mitigating measures, alternatives to the proposed actions, significant issues for analysis in the EIS, and potential development scenarios. A Fact Sheet with similar announcements/requests was sent to interested State and Federal agencies, industry, environmental groups, and individuals. Follow-up contact was made with the Governors and OCS Policy Committee members to give additional opportunity for scoping and input into the development scenarios.

(5) Meetings: An RTWG meeting was held on October 21, 1985, in New Orleans, Louisiana. Scoping efforts concerning the proposed 1987 sales were conducted at this meeting in addition to a discussion on the concern of ocean incineration in the Western Gulf. Biological stipulation revisions were also described.

A meeting with other DOI agency representatives was held under the authority of DM 655 on October 24, 1985, in New Orleans, Louisiana, to discuss archaeological and biological stipulations and trash on the beach.

A second DM 655 meeting was held in Metairie, Louisiana, to discuss biological stipulations and trash on the beach.

In addition to information gathered from the major steps in the process, comments on Draft EIS 104/105 which were pertinent were also used as scoping information for this Draft EIS.

MMS maintains an ongoing scoping process through the consultation and coordination of activities of individual staff members with counterparts in State and Federal agencies.

An analysis of the impact topics and alternatives considered during the scoping process is provided in Section I.B.2.

CALL FOR INFORMATION/NOTICE OF INTENT

A total of 11 responses were received: 3 from states; 7 from industry; and 1 from a Federal Government agency. Below is a summary of pertinent comments:

State of Alabama: The State Oil and Gas Board of Alabama recommended that additional studies be performed on the live bottoms in both the Central and Western portions of the Eastern Gulf. It is felt that MMS should initiate studies to define these areas and to provide environmental data for sound decisions. Of special interest to the State are the live bottom areas in Destin Dome Block 617. The State feels MMS should maintain consistency between Visual Nos. 10 and 11.

State of Texas: The Texas Department of Water Resources (TDWR) responded that based on observations of past oil and gas lease sales offshore Texas, they foresee that no adverse insuperable onshore problems resulting from continued leasing are likely to occur. Furthermore, they feel that the State of Texas should direct its efforts and support to the furtherance of the National energy interest. TDWR believes that further OCS lease sales should be exempted from further repetitive environmental analysis and studies. And finally, the burden of supplying and evaluating the substantive data needed by MMS to manage the OCS resource development and production programs should be borne by revitalized ocean programs of the USGS and by private sector industry contractors. State agencies do not appear to have the financial or other resources necessary to provide the data requested by MMS.

Texas Parks and Wildlife Department responded that it is possible that activities associated with the development of oil and gas deposits could impact biological resources of the State of Texas. They felt that recreational fishing and other recreational marine activities should be included as items of special concern in the environmental analysis. Appropriate oil spill contingency/containment plans should also continue to be addressed. They reiterated their recommendation for alternatives which minimize the potential for significant impacts to known biological sensitive banks such as the Flower Garden Banks. Finally, they feel that although the East and West Flower Garden Banks (High Island Area Blocks A-375 and A-398) are deferred from the proposed sale, the potential for biological impacts from oil spills and other oil and gas activities offsite exist and should be analyzed. To a lesser extent, this applies to the 123 blocks in the provisional United States maritime boundary with Mexico.

Federal Agency: The USEPA had no specific comments to offer at this time. They did, however, enclose a list of environmental laws with summaries that should be considered in preparing the Draft EIS. They are as follows:

Clean Air Act
Noise Control Act of 1972
Federal Water Pollution Control Act, as amended by the Clean Water Act of 1977

Federal Insecticide, Fungicide, Rodenticide Act
Resource Conservation and Recovery Act
Soil and Water Conservation Act
Endangered Species Act
Fish and Wildlife Conservation Act
Archaeological Resources Protection Act
Hazardous Material Transportation Act
American Indian Religious Freedom Act
Occupational Safety and Health Act of 1970

Industry: Shell recommended the modification of the existing schedule to set a fixed 6-month interval of sales in the two planning areas to allow industry to more efficiently utilize staff, seismic, and other exploration resources throughout the year in the evaluation process. They also recommend a fixed 10-year term for leases in all water depths greater than 400 m.

Amoco strongly objected to the continued arbitrary deferral of blocks in water depths greater than 2,400 m.

Exxon Company U.S.A. submitted copies of comments prepared for Draft EIS 94/98/102 and scoping comments for Draft EIS 104/105. They basically support a supplemental EIS approach. They feel we should eliminate redundancy where no change (or slight change) is evident from EIS to EIS. A significant uncertain impact or "worst case scenario" should be accompanied by: (1) evidence that there is a presumable possibility the event will occur; (2) a data base for evaluating its consequences that has been or can be established at reasonable costs; and (3) a showing that the likelihood of the event occurring is significantly increased by the project.

Sohio recommends an avoidance of last minute modification of sales. They feel that such disruptions tend to be very expensive and strategically destructive. It is preferable that once the sales have been scheduled, no other alternatives be made which would cause a major disruption in sale planning efforts.

RESOURCE REPORTS

Requests for Resource Reports for the Draft EIS for proposed Sales 110 and 112 were sent to Federal and State agencies an industry on August 16, 1985. In most cases, specific technical information was requested. The following is a summary of the responses received:

Federal Agencies

NOAA - National Marine Fisheries Service (NMFS): NMFS provided a list of sources which can be used to answer the specific technical questions asked.

Mobile District Corps of Engineers (COE): The COE provided a copy of the mobile District's most recent project map book and a copy of the generic EIS, including the executive Summary and Appendices, prepared for the exploration of hydrocarbon resources in coastal Alabama and Mississippi.

POST AREA IDENTIFICATION SCOPING

On October 3, 1985, the Gulf of Mexico OCS Region mailed out letters to the affected States announcing the AI decision and requesting scoping information on potential mitigating measures and alternatives to the proposed actions, significant issues, and development scenarios.

Shortly thereafter, similar requests were sent to appropriate Federal and State agencies, industry, environmental groups, and interested individuals. We received one comment letter from the Office of the Governor for the State of Texas. These comments are summarized below:

State of Texas

Texas Air Control Board (TACB): Operating procedures and plans designed to prevent or quickly control spills, upsets, or well blowouts should be included in the development scenarios. The TACB also noted that future onshore facilities resulting from OCS development from proposed Sale 112 would need to be reviewed individually through the TACB's normal permitting procedure.

Texas Attorney General's (AG) Office: The AG's Office raised the concern with the utilization of the "areawide" leasing selection process and enclosed a copy of comments filed by the AG for the State which voices the opposition to the "areawide/promising acreage" selection approach.

Texas General Land Office (GLO): The GLO reiterated is strong concerns about MMS's "areawide" approach to OCS leasing, which the GLO believes is retained in the "promising acreage" approach for the Gulf of Mexico in the draft proposed Five-Year OCS Leasing Plan. The GLO believes ". . . that the offering of such vast acreage all at one time has the demonstrable effect of flooding the market, reducing the competition and resulting in the receipt of less than full market value for the nation's resources."

In order to facilitate meaningful evaluation of tracts offered for lease, the GLO urged MMS to return to the tract nomination process of OCS leasing called for in the OCSLA.

Bureau of Economic Geology, the University of Texas at Austin (BEG): The BEG would not object to decreasing the size of an EIS and gives an example of how this reduction may be made. The BEG also generally concurs with the development scenarios while citing a few specific shortcomings.

SUMMARY OF RTWG MEETING

At the October 21, 1985, meeting of the Gulf of Mexico Regional Technical Working Group (RTWG), the concern of ocean incineration in the Western Gulf dumping site was presented by the following panel:

Cheryl Vaughan, Minerals Management Service (MMS)
Darrel Brown, Environmental Protection Agency (USEPA)
Lew Herrin, Offshore Operators Committee (OOC)
Brian Kelley, United States Coast Guard (USCG)

Proposed regulations issued by USEPA early in 1985 resulted in that agency requesting deferral of all 224 blocks in the area for the 1986 sales, citing safety factors and incompatibility between uses.

Ms. Vaughan described the location of site and past burns of toxic substances conducted through USEPA. Mr. Brown presented the current situation on handling hazardous wastes and USEPA authority in ocean incineration actions. He pointed out research efforts and future needs, stating that public concern was over possible spills from collisions and dangerous emissions. Herrin presented industry's viewpoint that the area should not be closed to exploration and the need to coordinate actions, but commented that industry does not view ocean incineration as dangerous to the offshore workplace. Commander Kelly stated that the USCG is concerned with life and safety at sea and with protection of the marine environment. The agency is concerned with potential collisions at sea, air quality, and more research on area size.

MMS has responded in Final EIS 104/105 that joint use of the Gulf through coordination between MMS and USEPA is the preferred alternative for ocean incineration. Notices to Lessees and contacts with USEPA should eliminate any conflicts between USEPA and offshore exploration. The RTWG agreed to develop a resolution supporting a concept of flexible site designations so incineration could be located away from other activities by rotating the burn areas as necessary.

On other issues at the meeting, Douglas Elvers of MMS's Gulf of Mexico OCS Region outlined several methods of reducing the complexity, size, and redundancy of Gulf EIS's. These methods were generally accepted by the membership. The NOAA representative recommended use of one EIS as a regional master and then rewriting only those sections in need of updating for each lease sale.

The biological stipulation revisions were also described, calling for reduced requirements in some regions and increased requirement in others, particularly the Eastern Gulf. Consultation between MMS and FWS produced agreement on the revisions. General comments from RTWG members were favorable, with specific questioning of the need to shunt in 300 feet or greater water depths, protections for Sebree Bank, and the results of monitoring at Applebaum Bank.

RESULTS OF DM 655 MEETINGS

A DM 655 meeting was held at the International Hotel in New Orleans, Louisiana, on October 24, 1985, in conjunction with the Information Transfer Meeting (ITM) and the RTWG meeting.

The National Park Service (NPS) was unable to attend, but their concerns were given by phone and presented at the meeting by Villere Reggio. The meeting focused on issues concerning the 1987 series of lease sales.

A brief summary of the development of proposed alternative biological stipulations (Option B) for the 1987 sales was presented.

Most of the participants of the DOI workshop which formulated the alternative stipulation were present. The alternative stipulations, along with the rationale for their consideration, were sent to the interested parties in August 1985. Responses were received from two Federal agencies, four states, four industry representatives, one environmental group, and one academic representative. These comments were generally favorable and supportive of the stipulations review as more scientific data becomes available and were briefly summarized and discussed. Copies of the comments had been mailed to the workshop participants a few weeks prior to the meeting. It was decided that the workshop participants meet later that week to discuss the comments in detail and to decide how these comments affect the workshop's recommendations for the alternative biological stipulations.

Concerns of NPS were presented regarding the problem of oil and gas industry-related debris. The major problem is focused at Padre Island National Seashore, probably due to the physical oceanography of the Gulf. NPS is concerned that the regulations currently in place, which require marking of items, are not accomplishing the desired result, particularly 55-gallon drums. Mr. Reggio announced that he would be chairing an ITM session which would focus in more detail on the trash problem and possible solutions. The participants were informed that MMS would further investigate the problem of permanent marking of items going offshore to assure that existing regulations are implemented.

A DM 655 meeting was held at the Imperial Office Building in Metairie, Louisiana, on March 20, 1986. Representatives from FWS, NPS, and MMS met to discuss the proposed biological stipulation revisions and concerns of the NPS on oil and gas activity near Everglades National Park and Fort Jefferson National Monument.

The attendees were in favor of the proposed stipulation revisions formulated by the biological workshop. Additional refinement of the topographic features stipulation was proposed by FWS and agreed upon. A "3 Mile Zone" would be implemented in which shunting of development and production effluent would be required at the shelf-edge banks (except for Fishnet and Diaphus Banks).

MMS may, as a condition of plan approval, require shunting of exploratory wells within this "3 Mile Zone." FWS suggested that the public be placed on notice that such a requirement may be necessary if numerous exploratory wells are proposed in proximity to a shelf edge bank during the same time period.

NPS expressed three concerns about the possibility of drilling activity occurring in South Florida in 1986. Noting the trash problem at Padre Island, NPS expressed concern about the potential for oil and gas industry-related trash to occur at Everglades National Park and Fort Jefferson National Monument. NPS contends that such a problem would be serious due to the fact that currently the Everglades and Fort Jefferson are trash free. A provision (possibly in the form of a stipulation) was recommended to provide for cleanup of oil- and gas-related trash at these two areas.

NPS also expressed concern about the possible effects of an oil spill on the Everglades and Fort Jefferson. They pointed to the lack of information on the effects of dispersants. Furthermore, NPS is opposed to the use of dispersants within these areas. NPS noted that due to the proximity of leases to the Everglades and Fort Jefferson and due to the water currents and geostrophic conditions in the area, the potential for impact to National lands from a spill is great. Due to the lack of lead time, storage of spill containment equipment at Key West would be inadequate. NPS expressed concern that the Regional Spill Contingency Plan does not include the Everglades or Fort Jefferson. Completion of an analysis necessary to develop a contingency plan for the Everglades and Fort Jefferson would be costly (the data are available; a mapping effort is required). It was recommended that NPS pursue efforts to include the Everglades and Fort Jefferson in the Regional Spill Contingency Plan through Departmental channels.

And finally, the NPS expressed concern about impacts to the habitats of the Everglades and the Florida Keys if drilling were to occur in the Florida Straits area.

COMMENTS ON DRAFT EIS 104/105 PERTINENT TO SCOPING FOR DRAFT EIS 110/112

Twenty-three letters of comments on Draft EIS 104/105 were received by MMS. Comments were received from nine Federal agencies, eight State agencies, one educational institution, one environmental group, and four oil- and gas-related companies.

The following is a summary of the letters pertinent to scoping for this Draft EIS:

Federal Agencies

U.S. Department of Transportation

Research and Special Programs Administration. It was suggested that additional clarification be provided concerning Federal safety regulations of oil and gas pipeline facilities.

Nuclear Regulatory Commission

The agency called attention to the need to examine, in greater detail, radionuclide content of produced waters in the Gulf of Mexico OCS.

U.S. Department of Commerce

National Marine Fisheries Service. The Service expressed concern that operational field personnel of the oil and gas industry may not observe restrictions in the no activity zones that pertain to anchors and anchor chains. It was recommended that Sebree Bank be afforded special protection under the biological stipulations and that a monitoring program be initiated at East Breaks.

U.S. Department of the Interior

National Park Service. The Service asked for more studies that are devoted to oil spill pollution, fates, and effects of low level pollution in the Gulf of Mexico and beach debris as it may impact NPS areas. Beach debris cleanup costs should be addressed more completely, taking into account hazardous waste, aesthetics, water quality, wildlife, and public safety. Wetland impacts should be addressed specifically as an issue. Oil spill containment and mitigation should receive more extensive discussion.

U.S. Fish and Wildlife Service. More detail is called for in the analysis of endangered and threatened species. Specific targets are urged for the oil spill risk analysis, and more analysis of shunting effects on topographic highs is suggested. The Service did not feel that a general statement saying ocean currents around banks will prevent deposition of drilling muds on sensitive biological communities was correct.

National Park Service, Southeast Regional Office. This agency reaffirms its concern with debris on the Gulf beaches and requested mitigation clarification. It was recommended visual and noise impacts on Ship, Horn, and Petit Bois Islands be assessed.

National Park Service, Southwest Regional Office. The opinion was expressed that impact assessments for recreational beaches and tourist activity are underestimated. It was pointed out that trash on the beach is avoidable and cleanup cost should be borne by lessors. An option to the proposed action is urged to require enforcement of stringent regulations of litter treatment.

U.S. Environmental Protection Agency

USEPA supports the inclusion of the stipulations in the proposed action; however, they question the adequacy of the stipulation to protect against the cumulative effects of oil and gas activity on topographic highs. The agency called for additional alternatives to the proposed action, i.e., areawide leasing. It was suggested that the EIS focus its discussion on areas most likely to receive more oil and gas activity. It was recommended that air quality modeling results be presented in the EIS. It is suggested that space/use conflicts between drilling and future incineration sites be further examined and discussed. The cumulative impact analysis should include the total find analysis.

U.S. Department of State

Bureau for Ocean and International Environmental and Scientific Affairs. A discussion of the United States/Mexico (hydrocarbon) spill agreement should be included in the Final EIS.

State of Texas

Texas General Land Office. It was pointed out the full extent of some critical wildlife habitats is incompletely mapped on Visual No. 3 and some place names are incorrect on Visual No. 11.

Texas Parks and Wildlife Department. The Department urges that oil spill contingency/containment plans remain in place and are ready for deployment. The Department concurred that the stipulations be made part of the proposed action and that the stipulations be applied so as to protect sensitive areas. Support was expressed for continued impact analysis of oil spills.

State of Alabama

Alabama Geological Survey. Studies of live bottom resources and improved mapping of the Mobile and Viosca Knoll Areas was called for by this agency. In the same areas, it is urged that fates and effects monitoring for drilling near live bottoms be conducted and that baseline studies in the Destin Dome Area be initiated.

Alabama Historical Commission. It was suggested that a literature search and magnetometer survey for each lease block be conducted and that an archaeological resource assessment be made for land-based support facilities.

State of Florida

North Central Florida Regional Planning Council. The sensitivity of Dixie and Taylor Counties (Florida) to oil spills was emphasized.

Industry

Shell Offshore Inc. It is recommended that lease sales in the WPA and CPA be held at not less than six months apart so as to allow industry to prepare for each sale. The Draft EIS section on a worst case oil spill is not needed based on known conditions and industry-wide safeguards.

Exxon Company, USA. It was recommended that supplemental EIS's be prepared for future Gulf sales so as to avoid repetition and redundancy.

Environmental Group

Sierra Club (Houston Regional Group). The Sierra Club felt that MMS should offer an alternative concerned with alternative energies, that 10-year leases be dropped to five years, that all leasing of blocks adjacent to the Flower Gardens be deferred indefinitely, and that all topographic highs in the WPA be offered as a deletion alternative.

C. DISTRIBUTION OF THE DRAFT EIS FOR REVIEW AND COMMENT

Copies of the Draft EIS will be sent to the agencies/groups listed below for their review and comment. Each reviewer contributes to the improved accuracy and understanding of the document.

Federal Agencies

- Department of Agriculture
  - Soil Conservation Service
- Department of Commerce
  - National Oceanic and Atmospheric Administration
    - Office of Ecology and Environmental Conservation
    - Marine Sanctuary Office
  - National Marine Fisheries Service

- Department of Defense
  - Department of the Air Force
  - Department of the Army
    - Corps of Engineers
  - Department of the Navy
- Department of Energy
  - Strategic Petroleum Reserve
- Department of the Interior
  - Bureau of Mines
  - Fish and Wildlife Service
  - Geological Survey
  - Minerals Management Service
  - National Park Service
- Department of State
  - Bureau for Oceans and International Environmental and Scientific Affairs
- Department of Transportation
  - Coast Guard
  - Materials Transportation Bureau
  - Office of Pipeline Safety Regulations
  - Research and Special Programs Administration
- Environmental Protection Agency
- Gulf of Mexico Fishery Management Council
- Marine Mammal Commission
- Nuclear Regulatory Commission
- Padre Island National Seashore

State and Local Agencies

- Alabama
  - Governor's Office
  - Alabama Geological Survey
  - Alabama Historical Commission and SHPO
  - Alabama State Clearinghouse
  - Alabama State Oil and Gas Board
  - Dauphin Island Marine Laboratory
  - South Alabama Regional Planning Commission

- Mississippi
  - Governor's Office
  - Bureau of Marine Resources
  - Gulf Regional Planning Commission
  - Mississippi Department of Archives and History
  - Mississippi Department of Planning and Policy
  - Mississippi State Clearinghouse

- Louisiana
  - Governor's Office
  - Acadiana Regional Clearinghouse
  - Calcasieu Regional Planning Commission
  - Capital/Region Planning Commission
  - Department of Culture, Recreation, and Tourism
  - Department of Natural Resources
  - Department of Urban and Community Affairs
  - Department of Wildlife and Fisheries

Lafayette Regional Planning Commission
Louisiana Geological Survey
Louisiana State Clearinghouse
Louisiana Wildlife Federation
Office of State Planning
Southwest Regional Clearinghouse
Teche Regional Clearinghouse

Florida
Governor's Office
Apalachee Regional Planning Council
Apalachicola Regional Planning Council
Central Florida Regional Planning Council
Charlotte County Planning Department
Executive Office of the Governor
Florida Audubon Society
Florida Department of Natural Resources
Florida Department of State
Florida State Clearinghouse
Florida State Historic Preservation Officer
ManaSota 88
North Central Regional Planning Council
South Florida Regional Planning Council
Southwest Florida Regional Planning Council
Tampa Bay Regional Planning Council
West Florida Regional Planning Council
Withlacoochee Regional Planning Council

Texas
Governor's Office
Golden Crescent Council of Governments
Office of Operations and Enforcement, Southwest Region
Southeast Texas Regional Planning Commission
Texas Coastal and Marine Council
Texas Commission on Natural Resources
Texas Department of Water Resources
Texas Historical Commission
Texas Parks and Wildlife Department
Texas State Clearinghouse

Libraries

Alabama
Auburn University Library
City of Mobile Public Library
City of Montgomery Public Library
Thomas D. Russell Library
University of Alabama at Huntsville Library
University of Southern Alabama Library

Florida
Charlotte Glades Regional Library
Coleman Memorial Library, Florida A&M University
Florida Atlantic University Library

- Florida State University Library
- Holland Law Center Library, University of Florida
- Northwest Regional Library System
- Selby Public Library
- St. Petersburg Public Library
- Tampa-Hillsborough County Public Library
- University of Florida Library
- University of Miami Library
- University of South Florida Library
- West Florida Regional Library

Louisiana
- Center for Wetland Resources Library, Louisiana State University (LSU)
- Howard Tilton Memorial Library, Tulane University
- Lafayette Public Library
- LSU at Eunice, Ledoux Library
- LSU Library
- Louisiana Tech University Library
- New Orleans Public Library
- Nicholls State University Library
- Northwest Sate University Library
- University of New Orleans Library
- University of Southwestern Louisiana Library

Mississippi
- Harrison County Public Library
- Mississippi State University Library
- University of Mississippi Library

Texas
- Austin Public Library
- Austin State University Library
- Baylor University Library
- Brazoria County Library
- Dallas Public Library
- East Texas State University Library
- Houston Public Library
- Lamar University Library
- La Ratama Library
- Rosenburg Library (Galveston)
- Sam Houston State University Library
- San Antonio College Library
- Texas A&M University Library
- Texas Southmost University Library
- Texas State Library at Austin
- Texas Technical University Law Library
- Trinity University Library
- University of Houston Library
- University of Texas at Dallas Library
- University of Texas at El Paso Library
- University of Texas Law Library
- University of Texas Library
- University of Texas at San Antonio Library

Academic Institutions

Arizona State University
Baylor University
Center for Bio-Organic Studies
Institute of Renewable Resources
Louisiana State University
Louisiana Universities Marine Consortium Council
Southern Methodist University
Texas A&M University
University of New Orleans
University of Texas

Industrial Firms

Atlantic Richfield
Clean Gulf Associates
Exxon Company, USA
John Chance and Associates
Shell Offshore Inc.

Groups and Individuals

American Association of Petroleum Landmen
American Fisheries Society
American Institute of Nautical Archaeology
American Petroleum Institute
Ecology Center of Louisiana
Environmental Confederation of Southwest Florida
Environmental Information Center (Florida)
First Freeport National Bank
Fishermen's Contingency Fund
Fishermen's Gear Compensation Fund
Florida Wildlife Federation
Greenpeace
Gulf Coast Research Lab
Gulf Islands National Seashore
Gulf Islands National Wildlife Refuge Complex
Gulf of Mexico Fishery Management Council
Izaak Walton League (Florida)
Johnson and Associates
League of Women Voters
Louisiana Audubon Society
Louisiana Environmental Professionals Association
Louisiana Historical Center
Louisiana Nature Center
Louisiana Oyster Association
Louisiana Shrimp Association
Louisiana Wildlife Biologist Association
LUMCON
Lyle St. Amant Marine Lab
Mississippi Chapter, Sierra Club
Mississippi Coast Audubon Society
Mississippi Coast Fisheries Association

Mississippi Sea Grant Advisory Service
Mississippi Wildlife Federation
National Oceanic Industries Association
Natural Resources Defense Council, Inc.
Organization for Artificial Reefs
Orleans Audubon Society
Oystershell Alliance and Save Our Wetlands
Peace River Audubon Society
Petroleum Information Composition
Port of Corpus Christi Authority
San Antonio Conservation Society
Sanibel-Captiva Audubon Society
Sanibel-Captiva Conservation Foundation, Inc.
Sarasota Audubon Society
Save Our Wetlands
Sierra Club, Florida Chapter
Sierra Club, Houston Chapter
Sierra Club, Lone Star Chapter
Sierra Club, New Orleans Chapter
Southeast Texas Resources
Southwest Culture Resources Center
Tampa Audubon Society
Texas Environmental Coalition
Texas Shrimp Association
Texas Water Conservation Association
Times Picayune-States Item
Venice Area Audubon Society

SECTION VI

BIBLIOGRAPHY AND SPECIAL REFERENCES

VI

VI

VI. BIBLIOGRAPHY AND SPECIAL REFERENCES

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SECTION VII

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VII

VII

VII. PREPARERS

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No. 12	Oil Spill Risk Analysis Overlay	Lawrence R. Handley, Michael K. Burdette
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No. 14	Tables of Environmental Resources	Joseph A. Christopher, Jerry Brashier, Heino Beckert Vivian E. Fine

SECTION VIII

GLOSSARY

VIII

VIII

VIII. GLOSSARY

Aliphatic - Of or pertaining to any organic compound of hydrogen and carbon characterized by a straight chain of the carbon atoms; three subgroups of such compounds are alkanes, alkenes, and alkynes.

Analysis Area - An OCS subplanning area or other OCS area (i.e., Eastern subplanning area E-4x) plus the adjacent coastal subarea; e.g., Eastern Analysis Area E-3 is composed of the offshore Eastern subplanning area E-3 plus Eastern coastal subarea E-3.

Anticline - An upfold or arch of stratified rock in which the beds or layers bend downward in opposite directions from the crest or axis of the fold.

API gravity - A special function of relative density which is the inverse of the usual scientific specific gravity term. It actually expresses a function of volume per unit weight with a higher number indicating that the crude oil (or other petroleum material) contains a higher content of gasoline and other light components.

Areas of high marine productivity - Include such areas as open bays, estuaries, and sounds that are used by finfish and shellfish as nursery and/or spawning grounds and may contain oyster reefs; nearshore Gulf areas that are important harvest grounds for menhaden and industrial bottomfish and/or finfish and shellfish spawning grounds; and coral areas in the vicinity of the Florida Keys.

Aromatic - Applied to a class of organic compounds containing benzene rings or benzenoid structures.

Asphaltene - Any of the dark, solid constituents of crude oils which are soluble in carbon disulfide but insoluble in paraffin napthas.

Ballast treatment - Treatment of a tanker's ballast water, which is contaminated by residuals of the original tanker cargo.

Barrel - Equal to 42 gallons.

Basin - A depression of the earth in which sedimentary materials accumulate or have accumulated, usually characterized by continuous deposition over a long period of time; a broad area of earth beneath which the strata dip, usually from the sides toward the center.

Biological opinion - An appraisal from either FWS or NMFS evaluating the impact of a proposed activity on endangered and threatened species.

Block - A geographical area, as portrayed on an official MMS protraction diagram or leasing map, that contains approximately nine square miles (2,304 hectares or 5,760 acres).

Blowout - Refers to an uncontrollable flow of fluids from a wellhead or wellbore. Unless otherwise specified, a flow of fluids from a flowline is not considered a blowout as long as the wellhead control valves can be automatically or manually activated. If the wellhead control valves become inoperative, the flow is classified as a blowout.

Blowout preventer - A stack or an assembly of heavy-duty valves attached to the top of the casing to control well pressure.

Bottomland hardwoods - Plant community typical of seasonally flooded floodplains.

Bunker fuel - Heavy residual fuel oil used in ships' boilers and in large heating and generating plants.

Caprock - A disk-like plate over all or part of the top of most salt domes in the Gulf coast states, composed of anhydrite, gypsum, limestone, and occasionally sulfur. Caprock may also be a comparatively impervious stratum immediately overlying an oil- or gas-bearing rock in an anticline.

Central Analysis Area - The Central Planning Area plus the Central Coastal Area.

Central Coastal Area - The onshore and coastal state water areas of Alabama, Mississippi, and Louisiana.

Central Planning Area - The sale area offshore Alabama, Mississippi, and Louisiana.

Central subplanning area - A discrete subarea within the larger offshore planning area.

Cetacean - A marine mammal such as whales, dolphins, porpoises, and related forms.

Coastal subareas - Discrete analysis areas (consisting of several counties/parishes) within the larger offshore coastal areas.

Coastal waters - Those waters surrounding the continent which exert a measurable influence on uses of the land.

Coastal wetlands - Include forested and nonforested habitats, mangroves, and all marsh islands which are exposed to the Gulf of Mexico waters. Acreage and shoreline distances for these categories can be found on Visual No. 14. Included in forested wetlands are hardwood hammocks, cypress-tupelogum swamps, and fluvial vegetation/bottomland hardwoods. Nonforested wetlands include fresh, brackish, and salt marshes. These areas directly contribute to the high biological productivity of coastal water by input of detritus and nutrients, by providing nursery and feeding areas for shellfish and finfish, by serving as habitat for many birds and other animals, and by providing waterfowl hunting and fur trapping.

Coastal zone - The coastal waters (including the lands therein and thereunder) and the adjacent shorelands (including the waters therein and thereunder), strongly influenced by each other and in proximity to the shorelines of the several coastal states, and includes islands, transitional and intertidal areas, salt marshes, wetlands, and beaches. The zone extends seaward to the outer limit of the United States territorial sea. The zone extends inland from the shorelines only the extent necessary to control shorelands, the uses of which have a direct and significant impact on the coastal waters. Excluded from the coastal zone are lands the use of which is by law subject to the discretion of or which is held in trust by the Federal Government, its officers, or agents.

Commingling - Bringing together the production from wells, leases, pools, and fields with production of other operators.

Completion - Conversion of a development well or an exploratory well into a production well of oil and/or gas.

Condensate - Liquid hydrocarbons produced with natural gas that are separated from the gas by cooling and various other means. Condensate generally has an API gravity of 50°-120° and is water-white, straw, or bluish in color.

Conditional resources - Assessment of oil or gas resources under the assumption that economically recoverable resources exist within the area of interest.

Continental margin - A zone separating the emergent continents from the deep sea bottom.

Continental shelf - A broad, gently sloping, shallow feature extending from the shore to the continental slope.

Continental slope - A relatively steep, narrow feature paralleling the continental shelf; the region in which the steepest descent to the ocean bottom occurs.

Contingency plan - A plan for possible offshore emergencies prepared and submitted by the oil or gas operator as part of the Plan of Development and Production.

Deferral - Action taken by the Secretary of the Interior at the time of the Area Identification to remove certain areas/blocks from the proposed sale. Deferred areas could receive environmental description in the EIS but are not assessed as alternatives.

Deletion Alternative - An option available to the Secretary of the Interior to alter the proposed action in Alternative A by deleting areas/blocks from the sale. This action would normally take place after completed analysis is available in the Final EIS.

Delineation well - A well which is drilled for the purpose of delineating a discovered oil or gas reservoir, thereby enabling the lessee to determine whether to proceed with development and production.

Designated environmental preservation areas - Gulf of Mexico shorefront areas which have been established for the quality and significance of their natural environments. They have been legislatively, administratively, or privately protected from the developmental influences of man and are managed solely for the preservation, understanding, and appreciation of their natural attributes. Included are National Parks and Preserves, National and State Wilderness Areas, National Marine and Estuarine Sanctuaries, National Landmarks, Wildlife Sanctuaries, Florida Aquatic Preserves, and Environmentally Endangered Lands.

Detritus - Particulate organic matter originating primarily from the physical breakdown of dead animal and plant tissue (may also include the breakdown of inorganic material).

Detritivores - Animals whose diet consists of detritus and the microbial fauna attached to detrital particles.

Development - Activities that take place following discovery of minerals in paying quantities, including geophysical activity, drilling, platform construction, and operation of all onshore support facilities; and that are for the purpose of ultimately producing the minerals discovered.

Development well - A well drilled to a known producing formation in a previously discovered field. To be distinguished from a wildcat, or exploratory well and from an offset well.

Development/production service base - A service base which is used in support of offshore development and production activity.

Diapir - A piercing fold; an anticlinal fold in which a mobile core, such as salt, has broken through the more brittle overlying rocks.

Dilution - The reduction in the concentration of dissolved or suspended substances by mixing with water.

Discharge - Something that is emitted; flow rate of a fluid at a given instant expressed as volume per unit of time.

Discovery - The initial find of significant quantities of fluid hydrocarbons on a given field on a given lease.

Dispersion - A distribution of finely divided particles in a medium.

Dome - A roughly symmetrical upfold, the beds dipping in all directions, more or less equally, from a point; any structural deformation characterized by local uplift approximately circular in outline, for example, the salt domes of Louisiana and Texas.

Drill ship - A self-propelled, self-contained vessel equipped with a derrick amidship for drilling wells in deepwater.

Drilling mud - A special mixture of clay, water, or refined oil, and chemical additives pumped downhole through the drill pipe and drill bit. The mud cools the rapidly rotating bit; lubricates the drill pipe as it turns in the well bore; carries rock cuttings to the surface; serves to keep the hole from crumbling or collapsing; and provides the weight or hydrostatic head to prevent extraneous fluids from entering the well bore and to control downhole pressures that may be encountered (drilling fluid).

Eastern Analysis Area - The Eastern Planning Area plus the Eastern Coastal Area.

Eastern Coastal Area - The onshore and coastal state water areas of Florida.

Eastern Planning Area - The sale area offshore Florida and offshore Baldwin County, Alabama.

Eastern subplanning area - A discrete subarea within the larger offshore planning area.

Economically recoverable resource estimate - An assessment of hydrocarbon potential that takes into account the physical and technological constraints on production and the influence of costs of exploration and development and market price on industry investment in OCS exploration and production.

Effluent - The liquid waste of sewage and industrial processing.

Endangered and threatened species - Those species identified in 43 FR 238 (December 11, 1978) and subsequent publications.

Environmental impact statement - A statement required by the National Environmental Policy Act of 1969 (NEPA) or similar State law in relation to any major action significantly affecting the environment; a NEPA document.

Estuary - Semienclosed coastal body of water which has a free connection with the open sea and within which seawater is measurably diluted with fresh water.

Eutrophic(ation) - A body of water rich in dissolved nutrients (as phosphates) but often shallow and seasonally deficient in oxygen.

Expected impact - Those alterations or changes to environmental conditions estimated to be probable or likely to occur as a result of a proposed action.

Exploration - The process of searching for minerals. Exploration activities include: (1) geophysical surveys where magnetic, gravity, seismic, or other systems are used to detect or infer the presence of such minerals and (2) any drilling, except development drilling, whether on or off known geological structures. Exploration also includes the drilling of a well in which a discovery of oil or natural gas in paying quantities is made and the drilling, after such a discovery, of any additional well that is needed to delineate a reservoir and to enable the lessee to determine whether to proceed with development and production.

Exploratory well - A well drilled in unproved or semi-proven territory for the purpose of ascertaining the presence underground of a commercial petroleum or natural gas deposit.

Exposed coastline - Shoreline areas that can be directly impacted by activities in OCS waters (Visual No. 14). All of the shoreline not classified as unexposed is exposed.

Fault - A fracture in the earth's crust accompanied by a displacement of one side of the fracture with respect to the other.

Field - An area within which hydrocarbons have been concentrated and trapped in economically producible quantities in one or more structural or stratigraphically related reservoirs.

Florida hammocks - Areas of higher elevation than their surroundings and characterized by hardwood and/or palm vegetation.

Flowlines - Pipelines that move oil from a header system, tank platform, or other facility to a point of final metering, processing, and/or sale.

Gathering lines - Pipelines used to bring oil from production leases by separate lines to a central point, that is, a tank farm or a trunk pipeline.

Geochemical - Of or relating to the science dealing with the chemical composition of and the actual or possible chemical changes in the crust of the earth.

Geologic hazard - A feature or condition that, if unmitigated, may seriously jeopardize offshore oil and gas exploration and development activities. Mitigation may necessitate special engineering procedures or relocation of a well.

Geomorphology - The science of surface landforms and their interpretation on the basis of geology and climate.

Geophysical - Of or relating to the physics of the earth, especially the measurement and interpretation of geophysical properties of the rocks in an area.

Geophysical survey - The exploration of an area during which geophysical properties and relationships unique to the area are measured by one or more geophysical methods.

Habitat - A specific type of place that is occupied by an organism, a population, or a community.

Herbivores - Animals whose diet consists of plant material.

High density offshore shellfish areas - Include nearshore areas known to have the highest concentrations of commercially important shrimp, spiny lobster, and stone crab.

Hydrocarbon - Any of a large class of organic compounds containing primarily carbon and hydrogen, comprising paraffins, olefins, members of the acetylene series, alicyclic hydrocarbons, and aromatic hydrocarbons, and occurring in many cases in petroleum, natural gas, coal, and bitumens.

Impact - A measurable alteration or change in environmental conditions.

Industry infrastructure - The facilities associated with oil and gas development, e.g., refineries, gas processing plants, etc.

Jack-up rig - A barge-like, floating platform with legs at each corner than can be lowered to the sea bottom to raise the platform above the water.

Land segment - A subarea, usually consisting of one or more counties or parishes, within the coastal subarea (see Visual No. 12).

Landfall - The site at which a marine pipeline comes to shore.

Land use - The function for which people employ an area of land.

Lay barge - A shallow-draft, barge-like vessel used in the construction and laying of underwater pipelines.

Lease - Any form of authorization which is issued under Section 8 or maintained under Section 6 of the Outer Continental Shelf Lands Act and which authorizes exploration for, and development and production of, minerals.

Lease sale - The competitive auction of leases granting companies or individuals the right to explore for and develop certain minerals within a defined period of time.

Lease term - For oil and gas leases, a period of either five years or up to ten years (when a longer period is necessary to encourage exploration and development in areas because of unusually deep water or other adverse conditions (see primary term)).

Lighter - A barge or small tanker used to move cargo from a large ship to port; also, to transport by lighter.

Major shorefront recreational beaches - Those frequently visited sandy areas along the shorefront exposed to the Gulf of Mexico which support a multiplicity of recreational activity, most of which is focused at the land-water interface. Included are National Seashores and other selected areas in the National Parks System, State Park and Recreational Areas, county and local parks, urban beachfronts, and private resort areas.

Major accidents - Includes spills of 10,000 gallons (238 bbls) or more and includes those blowouts, explosions, and fires which result in major structural damage or loss of life.

Marshes - Persistent emergent nonforested wetlands characterized by vegetation consisting predominantly of cordgrasses, rushes, and cattails.

Military warning area - An area established within which the public is warned that military activities take place.

Offloading - Another name for unloading; offloading refers more specifically to liquid cargo, crude oil, and refined products.

Offshore marine recreational fishing - Hook and line sport fishing from a boat seaward of the beach in the Gulf of Mexico for fun, food and occasional incidental profit, inclusive of spearfishing.

Offshore monobuoy - A buoy system at which a tanker may anchor, discharge, or load petroleum products.

Oil spill - A sudden, unintentional, or accidental unplanned release of oil.

Operational discharge - A release of oil that is part of the routine operations of a function.

Order of magnitude - A range of magnitude extending from some value to ten times that value (example: a value larger by two orders of magnitude would be 100 times that value).

Organic matter - Material derived from living plant or animal organisms.

Outer Continental Shelf (OCS) - All submerged lands that comprise the continental margin adjacent to the United States and seaward of state offshore lands.

Penaeids - Chiefly warm water and tropical prawns belonging to the family Penaeidae.

Petroleum - An oily, flammable bituminous liquid that occurs in many places in the upper strata of the earth, either in seepages or in reservoirs; essentially a complex mixture of hydrocarbons of different types with small amounts of other substances; any of various substances (as natural gas or shale oil) similar in composition to petroleum.

Plan of Development and Production - A plan describing the specific work to be performed, including all development and production activities that the lessee(s) propose(s) to undertake during the time period covered by the plan and all actions to be undertaken up to and including the commencement of sustained production. The plan also includes descriptions of facilities and operations to be used, well locations, current geological and geophysical information, environmental safeguards, safety standards and features, time schedules, and other relevant information. Under 30 CFR 250.34-2, all lease operators are required to formulate and obtain approval of such plans by the Director of the Minerals Management Service before development and production activities commence.

Plan of Exploration - A plan based on available relevant information about a leased area that identified, to the maximum extent possible, the potential hydrocarbon accumulations and wells that the lessee(s) propose(s) to drill to evaluate the accumulations within the entire area of the lease(s) covered by the plan. Under 30 CFR 250.34-1, lease operators are required to formulate and obtain approval of such plans by the Director of Minerals Management Service before significant exploration activities may commence.

Plankton - Passively floating or weakly motile aquatic plants and animals.

Platform - A steel or concrete structure from which offshore development wells are drilled.

Porous - Containing void spaces that may be occupied by fluids.

Potable - Suitable for drinking.

Potential impact - The range of alterations or changes to environmental conditions that could be caused by a proposed action.

Primary production - Production of carbon by a plant through photosynthesis over a given period of time.

Primary term - The initial period of oil and gas leases, normally five years (see lease term).

Production - Activities that take place after the successful completion of any means for the removal of minerals, including such removal, field operations, transfer of minerals to shore, operation monitoring, maintenance, and workover drilling.

Production curve - A curve plotted to show the relation between quantities produced during definite consecutive time intervals.

Production schedule - A percentage distribution intended to show quantities of oil or gas produced over a consecutive time interval.

Production well - A well which is drilled for the purpose of producing oil or gas reserves. It is sometimes termed development well.

Province - An area throughout which geological conditions have been similar or that is characterized by particular structural, petrographic, or physiographic features.

Recoverable resource estimate - An assessment of oil and gas resources that takes into account the fact that physical and technological constraints dictate that only a portion of resources or reserves can be brought to the surface.

Refining - Fractional distillation, usually followed by other processing (for example, cracking).

Relief - The elevations or inequalities of a land surface.

Reserve estimate - An assessment of the portion of the identified oil or gas resource that can be economically extracted.

Reserves - Portion of the identified oil or gas resource that can be economically extracted.

Reservoir - An accumulation of hydrocarbons that is separated from any other such accumulation.

Rig - A structure used for drilling an oil or gas well.

Right-of-way - A legal right of passage, an easement; the specific area or route for which permission has been granted to place a pipeline, ancillary facilities, and for normal maintenance thereafter.

Risked, economically recoverable resource estimate - An assessment of oil or gas resources that has been modified to take into account: (1) physical and technological constraints on production; (2) the influence of the costs of exploration and development and market price on industry investment in OCS exploration and production; (3) and the uncertainty of the estimate and to account for the possibility that economically recoverable resources may not be found within the area of interest.

Saltwater intrusion - Phenomenon occurring when a body of salt water, because of its greater density, invades a body of fresh water. Occurs in either surface or groundwater sources.

Sciaenids - Fishes belonging to the croaker family (Sciaenidae).

Seagrass beds - More or less continuous mats of submerged rooted marine flowering vascular plants occurring in shallow tropical and temperate waters. Seagrass beds provide habitat, including breeding and feeding grounds, for adults and/or juveniles of many of the economically important shellfish and finfish. As such, this habitat type is especially sensitive to oil spill impacts.

Sediment - Material deposited (as by water, wind, or glacier) or a mass of deposited material.

Sedimentary rocks - Rock formed of mechanical, chemical, or organic sediment.

Seismic - Pertaining to, characteristic of, or produced by earthquakes or earth vibration; having to do with elastic waves in the earth.

Sensitive coastal habitats - Coastal habitats susceptible to damage from oil/gas-related OCS activities.

Sensitive offshore area - An area containing species, populations, communities, or assemblages of living resources, to which normal oil and gas exploration and development activities may cause irreparable damage, including interference with established ecological relationships.

Shunting - A method used in offshore oil and gas drilling activities where expended drilling cuttings and fluids are discharged near the ocean seafloor rather than at the surface, as is the case in normal offshore drilling operations.

Single point mooring (SPM) - Offshore anchoring and loading or unloading point connected to shore by an undersea pipeline. Used in areas where existing harbors are not deep enough for laden tankers.

Stratigraphic trap - A geologic feature that includes a reservoir, capable of holding oil or gas, that is formed from a change in the character or extent of the reservoir rock. Such a trap is harder because it is not dependent on structural closure and is thus not readily revealed by geological or geophysical surveys.

Subsea completion - A self-contained unit to carry men from a tender to the ocean bottom and enable them to install, repair, or adjust wellhead connections in a dry, normal atmosphere.

Subsea complex - A development well in which the assembly of valves, pipes, and fittings used to control the flow of oil or gas is located on or near the ocean floor.

Subsidence - A sinking of a part of the earth's crust.

Summary report - A document prepared by the Department of the Interior pursuant to 30 CFR 252.4 that is intended to inform affected state and local governments as to current OCS reserve estimates, projections of magnitude and timing of development, transportation planning, and general location and nature of nearshore and onshore facilities.

Supply boat - A vessel that ferries food, water, fuel, and drilling supplies and equipment to a rig and returns to land with refuse that cannot be disposed of at sea.

Sweet crude - Crude oil containing very little sulfur or sulfur compounds.

Sweet gas - Natural gas free of significant amounts of hydrogen sulfide (H_2S) when produced.

Total suspended solids (TSS) - The total content of suspended and dissolved solids in water.

Turbidity - Reduced water clarity resulting from the presence of suspended matter.

Ultra-large crude carrier (ULCC) (sometimes called a supertanker) - A tanker in excess of 300,000 dead weight tons.

Undiscovered resources - Quantities of oil and gas estimated to exist outside known fields.

Unexposed coastline - That shoreline bordered by sheltered waters, particularly where an embayment creates a calmer sea state. Direct exchange of seawater is limited by coastal inlets of about two or less miles across (Visual No. 14).

Unit - Administrative consolidation of OCS leases held by one or more companies but explored, developed, and/or produced as one lease by one operator for purposes of conservation, eliminating unnecessary operations, and/or maximizing resources recovered.

Vascular plants - Plants containing food and water conducting structures; higher plants which reproduce by seeds.

Very large crude carrier (VLCC) - A crude oil tanker of 160,000 dead weight tons or larger, capable of carrying one million barrels or more.

Vulnerability - The likelihood of being damaged by external influences. Vulnerability implies sensitivity of a system plus the risk of a damaging influence occurring.

Water test areas - Areas established within the Eastern Gulf where research, development, and the testing of military planes, ships, and weaponry takes place.

Weathering - The aging of oil due to its exposure to the atmosphere, causing marked alterations in its physical and chemical makeup.

Western Analysis Area - The Western Planning Area plus the Western Coastal Area.

Western Coastal Area - The onshore and coastal state water areas of Texas.

Western Planning Area - The sale area offshore Texas.

Western subplanning area - A discrete subarea within the larger offshore planning area.

Wetlands - Areas periodically inundated or saturated by surface or groundwater and supporting predominantly vegetation typically adapted for life in saturated soil conditions.

SECTION IX

APPENDICES

IX

Appendix A

Blocks Affected by the Biological Stipulations in the Central and Western Gulf of Mexico

Central Gulf of Mexico

A total of 177 blocks in the Central Gulf would be affected by the topographic features stipulation, 110 of which are currently leased. The blocks affected, leasing status, and affected bank follow.

West Cameron, South Addition

Block	OCS-G No.(if leased)	Bank
569		29 Fathom
570	5188	29 Fathom
589	5352	29 Fathom
590		29 Fathom
591	6600	29 Fathom
592	6601	29 Fathom
611	6603	29 Fathom
612	2557	29 Fathom and MacNeil
613	3286	MacNeil
614	6604	MacNeil
633	2238	MacNeil
634		Rankin
635		Rankin
636	4202	Bright
637	4097	Bright
638	2026	Bright
645	3973	Geyer
646	4411	Geyer
648	4268	Bright
649		Bright
650	6606	Bright
651		Bright
652	7636	Rankin and Bright
653	7637	Rankin
654	6607	Rankin
655		Rankin and Bright
656	6608	Bright
657		Bright
658	6609	Bright
659	6610	Bright
660	6611	Bright
661	6612	Bright
662		Bright and Rankin
663	6613	Rankin

East Cameron, South Addition

Block	OCS-G No.(if leased)	Bank
361	5396	McGrail
362	6656	McGrail
363	6656	McGrail

East Cameron, South Addition (continued)

Block	OCS-G No.(if leased)	Bank
377	7676	McGrail
378	6660	McGrail
379		McGrail

Vermilion, South Addition

Block	OCS-G No.(if leased)	Bank
284		Sonnier
285		Sonnier
286		Sonnier
297	4804	Sonnier
298		Sonnier
299		Sonnier
300		Sonnier
303	4805	Sonnier
304		Sonnier
305		Sonnier
306	4426	Sonnier
317		Sonnier
318	4427	Sonnier
319		Sonnier
320	2087	Sonnier
361	5448	Bouma
362	5449	Bouma
363		Bouma
369	2274	Bouma
370	2275	Bouma
371		Bouma
372	2576	Bouma
382		Bouma and Rezak
383	7694	Bouma and Rezak
384	7695	Bouma
385	5452	Bouma
386	2278	Bouma
387		McGrail
388		McGrail
389	6684	McGrail
390		McGrail
391		McGrail and Bouma
392		Bouma
393		Bouma and Rezak
394		Bouma and Rezak
395	5453	Rezak
396		Rezak
403		Rezak
404		Rezak
405		Rezak
406		Rezak and Bouma

Vermilion, South Addition (continued)

Block	OCS-G No.(if leased)	Bank
407		Bouma
408		McGrail
409		McGrail
410		McGrail
411		Sidner and Rezak
412	6685	Sidner and Rezak

South Marsh Island, South Addition

Block	OCS-G No.(if leased)	Bank
161	4809	Alderdice
162	4810	Alderdice
163		Alderdice
169		Alderdice
170		Alderdice
171	5467	Alderdice
172	4811	Alderdice
173	2887	Alderdice
176	5221	Alderdice
177	5468	Alderdice
178		Alderdice
179		Alderdice
180		Alderdice
185		Alderdice and Parker
186		Alderdice and Parker
187	7716	Alderdice and Parker
188	5469	Alderdice and Parker
193	6694	Parker
194	6695	Parker
195		Parker
196		Parker
197		Parker
200	7719	Parker
201	7720	Parker
202	7721	Parker
203		Parker
204	5474	Parker

Eugene Island, South Addition

Block	OCS-G No.(if leased)	Bank
335	6723	Fishnet
355	7740	Fishnet
356	5522	Fishnet
381		Jakkula
382		Jakkula

Eugene Island, South Addition (continued)

Block	OCS-G No.(if leased)	Bank
383		Jakkula
390	6730	Jakkula
391	6731	Jakkula
397	5529	Jakkula

Ship Shoal, South Addition

Block	OCS-G No.(if leased)	Bank
325	5574	Ewing
326	5575	Ewing
327	6753	Ewing
328	6754	Ewing
329		Ewing
334		Ewing
335		Ewing
336	6756	Ewing
337		Ewing
338		Ewing
339	6757	Ewing
348	5579	Ewing
349		Ewing
350		Ewing
351	5580	Ewing
352	5581	Ewing
353	6759	Ewing
356	5206	Ewing
357	5584	Ewing
358	5585	Ewing
359	5586	Ewing

South Timbalier, South Addition

Block	OCS-G No.(if leased)	Bank
314	5225	Diaphus
315	7918	Diaphus
316	5649	Diaphus
317	5650	Diaphus

West Delta, South Addition

Block	OCS-G No.(if leased)	Bank
142		Sackett
143	4475	Sackett
144	6789	Sackett
146		Sackett
147	4476	Sackett

West Delta, South Addition

Block	OCS-G No.(if leased)	Bank
148	4477	Sackett
149	5683	Sackett
154		Sackett

Green Canyon

Block	OCS-G No.(if leased)	Bank
4	5529	Jakkula
5	6986	Jakkula
6	6987	Jakkula
7	6988	Jakkula
49	7002	Jakkula
50	7989	Jakkula
90	4503	Sweet

Ewing Bank

Block	OCS-G No.(if leased)	Bank
903	5803	Ewing
932	6914	Jakkula
933	6914	Jakkula
944	5809	Ewing
945	6917	Ewing
947	5803	Ewing
975	6730	Jakkula
976		Jakkula
977	6926	Jakkula

Mississippi Canyon

Block	OCS-G No.(if leased)	Bank
316	5833	Sackett
317	6945	Sackett
318		Sackett
360	6947	Sackett
361	6948	Sackett

Western Gulf of Mexico

A total of 200 blocks in the Western Gulf would be affected by the topographic features stipulation, 126 of which are currently leased. The blocks affected, leasing status, and the affected bank follow.

North Padre Island, East Addition

Block	OCS-G No.(if leased)	Bank
A-30	5969	Dream
A-31	5970	Dream
A-40	5971	Dream
A-41	5972	Dream
A-72	5977	Blackfish Ridge
A-83	7159	Mysterious
A-84	7160	Mysterious

Mustang Island

Block	OCS-G No.(if leased)	Bank
A-3		North Hospital
A-4		North Hospital and Hospital
A-9		Southern
A-16	3011	Southern

Mustang Island, East Addition

Block	OCS-G No.(if leased)	Bank
A-54		Small and Big Dunn Bars
A-61		Baker

Mustang Island, East Addition (continued)

Block	OCS-G No.(if leased)	Bank
A-62	8086	Baker
A-86	8089	Baker and South Baker
A-87		Baker and South Baker
A-95	8090	South Baker
A-117	4697	Aransas and North Hospital
A-118	4698	Aransas
A-136		Aransas, Hospital, and North Hospital
A-137		Hospital

High Island, South Addition

Block	OCS-G No.(if leased)	Bank
A-446	2359	Claypile
A-447	2360	Claypile
A-448	2361	Claypile

High Island, South Addition (continued)

Block	OCS-G No.(if leased)	Bank
A-463	7337	Claypile
A-464		Claypile
A-465		Claypile
A-486	6227	Stetson
A-487	4743	Stetson
A-488	6228	Stetson
A-501	6233	Stetson
A-502	7339	Stetson
A-503	6235	Stetson
A-512		Stetson
A-513		Stetson
A-514		Stetson
A-527		Stetson
A-528		Stetson
A-529		Stetson
A-534		32 Fathom
A-535		32 Fathom
A-573	2393	West Flower Garden
A-578	4589	Applebaum
A-579	5012	Applebaum
A-580		Applebaum
A-589	7351	Applebaum
A-590		Applebaum
A-591	7352	Applebaum
A-596	2722	West Flower Garden

High Island, East Addition, South Extension

Block	OCS-G No.(if leased)	Bank
A-311	6250	29 Fathom
A-312	2409	29 Fathom
A-327	2418	29 Fathom
A-328		29 Fathom
A-329	6253	29 Fathom
A-330	2421	29 Fathom
A-331		29 Fathom
A-332	2422	29 Fathom
A-340	2426	Coffee Lump
A-346	4190	MacNeil
A-347		MacNeil
A-348		MacNeil
A-349	2743	MacNeil
A-350	2428	MacNeil
A-351	2429	MacNeil and East Flower Garden
A-352		East Flower Garden and MacNeil
A-353	7362	East Flower Garden
A-354		East Flower Garden

High Island, East Addition, South Extension (continued)

Block	OCS-G No.(if leased)	Bank
A-355	2745	East Flower Garden
A-358	6255	Coffee Lump
A-359		Coffee Lump
A-360	8190	Coffee Lump
A-361		Coffee Lump and West Flower Garden
A-362	7364	West Flower Garden
A-363		West Flower Garden
A-364	6256	East and West Flower Garden
A-365	2750	East Flower Garden
A-366	7365	East Flower Garden
A-367	7366	East Flower Garden
A-368	2433	East Flower Garden, Rankin, and MacNeil
A-369	2751	MacNeil and Rankin
A-370	2434	MacNeil and Rankin
A-371		Rankin
A-372		Rankin and MacNeil
A-373	7367	East Flower Garden, Rankin, and MacNeil
A-374	5108	East Flower Garden
A-375		East Flower Garden
A-376	2754	East Flower Garden
A-377	6258	East and West Flower Garden
A-378		West Flower Garden
A-379		West Flower Garden
A-380	7369	West Flower Garden
A-381	8192	West Flower Garden
A-382	2757	West Flower Garden
A-383	6259	West Flower Garden
A-384	3316	West Flower Garden
A-385	5109	West Flower Garden
A-386		East and West Flower Garden
A-387		East Flower Garden
A-388	6260	East Flower Garden
A-389	2759	East Flower Garden
A-390		East Flower Garden and Rankin
A-391		Rankin
A-392	6261	Rankin
A-393	7370	Rankin
A-394		East Flower Garden
A-395	7371	East Flower Garden
A-396	7372	East and West Flower Garden

High Island, East Addition, South Extension (continued)

Block	OCS-G No.(if leased)	Bank
A-397		West Flower Garden
A-398		West Flower Garden
A-399	7373	West Flower Garden
A-400	6263	West Flower Garden
A-401	6264	West Flower Garden
A-402	6265	West Flower Garden
A-403	6266	East Flower Garden

East Breaks

Block	OCS-G No.(if leased)	Bank
121		Applebaum
122	6271	Applebaum
123	7388	Applebaum
124		Applebaum
165	6280	Applebaum
166	6281	Applebaum
167	7392	Applebaum
168	7393	Applebaum
173	6284	West Flower Garden
217	7399	West Flower Garden

Garden Banks

Block	OCS-G No.(if leased)	Bank
26		McGrail
27	7431	McGrail
28	7432	McGrail
29	7433	McGrail
30	7434	Rezak and Sidner
31	7434	Rezak and Sidner
33		Rezak and Sidner
61		Geyer
62		Geyer
63		Geyer
70		McGrail
71		McGrail
72	7435	McGrail
73	7436	McGrail
74	7437	Sidner
75	7438	Sidner
76		Sidner
77	6328	Sidner
81		Parker

Garden Banks (continued)

Block	OCS-G No.(if leased)	Bank
82	6329	Parker
83	6330	Parker
84	6331	Parker
85		Parker
95	6332	East Flower Garden
96	6333	East Flower Garden
97		East Flower Garden and Rankin
98		Rankin
102		Bright
103	6334	Bright
104	6335	Geyer
105		Geyer
106		Geyer
107		Geyer
108	6336	Geyer and Elvers
109	6337	Elvers
110	6338	Elvers
119	6340	Sidner
120		Sidner
121	6341	Sidner
126	6343	Parker
127	6344	Parker
128	6345	Parker
133		West Flower Garden
134	8216	West Flower Garden
135	6346	West Flower Garden
136		West Flower Garden
138		East Flower Garden
139	6347	East Flower Garden
140	6348	East Flower Garden
141		Rankin
142	8217	Rankin
144		Bright
145		Bright
146		Bright
148	6350	Geyer
149	7440	Geyer
150		Geyer
151		Geyer
152	7441	Geyer and Elvers
153	8218	Elvers
154		Elvers
155		Elvers
177	6355	West Flower Garden
178	6356	West Flower Garden
179		West Flower Garden
180	7444	West Flower Garden
192	3301	Geyer

Garden Banks (continued)

Block	OCS-G No.(if leased)	Bank
193	4130	Geyer
194		Geyer
195	7445	Geyer
196	7446	Geyer and Elvers
197	7447	Elvers
198		Elvers
237	2812	Geyer
238		Geyer
239	6367	Geyer

Appendix B

NTL 83-3

UNITED STATES DEPARTMENT OF THE INTERIOR
MINERALS MANAGEMENT SERVICE
GULF OF MEXICO OCS REGION

83-3 September 7, 1983

NOTICE TO LESSEES AND OPERATORS OF FEDERAL OIL AND GAS LEASES IN THE OUTER CONTINENTAL SHELF, GULF OF MEXICO OCS REGION

OUTER CONTINENTAL SHELF SHALLOW HAZARDS REQUIREMENTS FOR THE GULF OF MEXICO OCS REGION

I. Introduction

In accordance with the provisions of 30 CFR 250.11(a), 250.34-1(k), 250.34-2(n), and 250.34-3, the Minerals Management Service (MMS) has established a shallow hazards program to ensure that exploratory, development, and production operations are conducted with a minimum risk to human life and the environment. This Notice to Lessees and Operators (NTL) specifies the requirements necessary to meet this objective in the Gulf of Mexico OCS Region.

The provisions of this NTL are intended to provide clarification, description, or interpretation of requirements contained in regulations or OCS Orders. This NTL does not impose additional requirements.

The purpose of this NTL is to consolidate, clarify, and formalize existing shallow hazards requirements. As a result, NTL 75-8, dated June 1, 1975, and NTL 80-5, effective July 1, 1980, are hereby cancelled. This NTL contains no changes in policy and very few changes from the requirements now in force.

The requirements of this NTL are effective immediately and shall apply to all existing and future leases and pipeline rights-of-way.

II. Shallow Hazards Analysis

A. Plans of Exploration (POEs) and Plans of Development/Production (POD/Ps)

All POEs and POD/Ps which propose seafloor-disturbing activities shall include a shallow hazards analysis for each proposed drilling or platform site. Detailed shallow hazards analyses of all pipeline routes shall be included in separate pipeline applications, not in POD/Ps.

A shallow hazards analysis for activities proposed in a POE or POD/P shall include the following:

1. A discussion and review of all available geological and geophysical data within 150 meters (490 feet) of each proposed operation.

2. An assessment of any seafloor and subsurface geologic and man-made features and conditions which may have an adverse effect on the proposed operations. Seafloor geologic hazards include fault scarps, gas vents, unstable slopes, and reefs. Subsurface geologic hazards include faults, gas-charged sediments, abnormal pressure zones, and buried channels. Man-made hazards include pipelines, wellheads, shipwrecks, ordnance, communication cables, and debris from previous oil and gas activities.

3. A specific discussion of mass movement of sediments, unstable slopes, active faulting, or gaseous sediments when required by the special operational constraints stipulation on some leases.

4. A discussion of any special safety measures that would minimize the adverse effects of shallow hazards on the proposed operations including a discussion on how compliance with the requirements of Section IV, paragraph B, of this NTL will be accomplished.

5. For leases issued after April 1983, a copy of high-resolution survey data from the two lines closest to the proposed well or platform location shall be included with one copy of each POE or POD/P.

In order to provide sufficient information on which to base a shallow hazards analysis, it will usually be necessary to conduct a shallow hazards survey, as described in Section III, paragraphs C.2.a. or C.2.b., of this NTL. However, if a thorough analysis can be made using available geological and geophysical information, including CDP and seismic bright spot data and seismic velocity data, a shallow hazards survey will not be required. If there is a question about the adequacy of available data to prepare an acceptable shallow hazards analysis, the appropriate District Supervisor may be contacted for guidance prior to submission of the POE or POD/P.

B. Applications for Permit to Drill

At the discretion of the appropriate District Supervisor, additional shallow hazards surveying and/or analysis may be required to support applications to drill individual wells. The District Supervisor may also request to review original survey data. These requirements are specified in paragraph 2.3 of OCS Order No. 2.

C. Platform Applications

Subparagraph 3.2.1.3.e of OCS Order No. 8 refers to the necessary shallow hazards information which shall accompany platform applications.

D. Pipeline Applications

All pipeline applications shall include a shallow hazards analysis that covers the entire length of the pipeline.

1. A shallow hazards analysis of pipelines for which a specific pipeline pre-installation survey was conducted shall include the following:

a. A shallow hazards report prepared in accordance with the requirements of Section III, paragraph D.2., of this NTL.

b. A discussion of any special safety measures that would minimize the effects of shallow hazards on the proposed pipeline including a discussion of how compliance with the provisions of Section IV, paragraph B, of this NTL will be accomplished.

2. A shallow hazards analysis of pipelines for which a specific pipeline pre-installation survey was not conducted shall include the following:

a. A discussion of the specific data and reports used to make the analysis.

b. An assessment of any seafloor and subsurface geologic and man-made features and conditions which may have an adverse effect on the proposed pipeline.

c. A discussion of any special safety measures that would minimize the adverse effects of shallow hazards on the proposed pipeline including a discussion of how compliance with the provisions of Section IV, paragraph B, of this NTL will be accomplished.

For right-of-way pipelines, it will be necessary to conduct a pipeline pre-installation survey as prescribed in Section III, paragraph C.2.d., of this NTL in order to prepare an acceptable shallow hazards analysis. However, for lease and permit pipelines, it may not be necessary to conduct a pipeline pre-installation survey if a thorough analysis can be made using available geological and geophysical data. If there is a question about the adequacy of available data to prepare an acceptable analysis, the Regional Supervisor, Offshore Rules and Production, may be contacted for guidance prior to submission of the pipeline application.

III. Shallow Hazards Surveys and Reports

A. Introduction

Since the following shallow hazards survey requirements are similar to those for other surveys (e.g., cultural resource and live-bottom), the operator is encouraged to conduct the surveys concurrently. When any of the survey requirements cannot be met for technical, logistical, or other justifiable reasons, an explanation of the problem must be provided in the shallow hazards report.

B. Data Acquisition Instrumentation

Geophysical instrumentation for shallow hazards surveys shall be representative of the state-of-the-art in technological development and shall be deployed in a manner which minimizes interference between the instrumentation systems. All data recorders shall be keyed to the navigation system to assure proper integration of information. The equipment operator shall ensure that all instrumentations are adequately tuned and that all recorded data are readable, accurate, and properly annotated.

The following instrumentation shall be utilized in conducting shallow hazards surveys unless sufficient justification is presented to the appropriate District Supervisor (or Regional Supervisor, Offshore Rules and Production for pipeline surveys) prior to conducting the survey that certain instrumentation is unnecessary.

1. Magnetometer

Total field intensity instruments shall be used to determine the presence of pipelines and other ferromagnetic objects. The sensor of the magnetometer should be towed as near as possible to the seafloor; a distance of six meters (20 feet) or less is preferred. Magnetometer sensitivity shall be one gamma or better, and the background noise level shall not exceed three gammas. Whenever possible, the magnetometer should be towed a minimum distance of three vessel lengths behind the vessel to eliminate its magnetic influence.

2. Side-Scan Sonar

Dual channel side-scan sonar systems shall be used to record continuous planimetric images of the seafloor. The system shall be operated in a manner that provides 100 percent coverage of the seafloor in the survey area. Data obtained should be of such quality so as to permit detection and evaluation of seafloor objects and features within the survey area.

The vertical sound beam width shall be appropriate to the water depth, and the horizontal sound beam width shall provide optimum resolution. The instrument shall be tuned to enhance echo returns from small nearby objects and features without sacrificing the quality of echo returns from more distant objects and features.

3. Shallow Penetration Subbottom Profiler

A subbottom profiler system shall be used to determine the character of nearsurface geological features. The systems used shall be capable of providing a resolution of at least one meter (three feet) within the upper 15 meters (50 feet) of sediment.

4. Medium Penetration Seismic Profiler

A profiler system shall be used to determine the character of deeper geological features. The system used shall be capable of penetrating at least 300 meters (980 feet).

For seafloor obstruction surveys and pipeline pre-installation surveys, as discussed in paragraphs C.2.c. and C.2.d. of this section, a medium penetration profiler system is not required.

5. Depth Sounder

Continuous water depth measurements shall be made using a high-frequency narrow-beam depth sounder. Bathymetric data shall be recorded with a recording sweep appropriate to topography and water depth.

6. Additional Investigations

Under certain conditions, additional instrumentation and methods such as underwater television, still or movie cameras, divers, coring, remote or manned submersibles, and additional geophysical survey lines may be necessary.

C. Survey Parameters

The following navigation and survey pattern requirements shall be utilized in conducting shallow hazards surveys:

1. Navigation

Navigation for the survey shall use a state-of-the-art continuous positioning system correlated with annotated geophysical records. The system shall have an accuracy appropriate to the survey area; ±15 meters (50 feet) or less is recommended. The nominal fix spacing shall be no more than 150 meters (490 feet).

2. Survey Pattern

The pattern for each type of survey shall be designed to cover the area of anticipated physical disturbances. This area includes but is not limited to the area within which drilling vessel or pipeline-lay barge anchors may be placed, but does not include the area within which work boat anchors will be placed or the area within which similar minimal disturbances may occur.

The following survey patterns shall be utilized in conducting shallow hazards surveys unless sufficient justification is presented to the appropriate District Supervisor (or Regional Supervisor, Offshore Rules and Production for pipeline surveys) prior to conducting the survey that a different survey pattern is adequate.

a. Lease Surveys - When multiple operations on the lease are planned or probable, it may be advantageous to conduct a lease survey. This survey shall cover the entire area of the lease, as well as that portion external to the lease within which operational activities may cause physical disturbances. The survey shall be run along parallel lines spaced at a maximum of 300 meters (980 feet) with cross lines spaced at a maximum of 900 meters (2950 feet).

b. Site-Specific Surveys - These surveys shall be run in an area at least 1800 meters (5900 feet) square with parallel lines spaced at a maximum of 300 meters (980 feet) with cross lines spaced at a maximum of 900 meters (2950 feet). Site-specific surveys are not required in areas where lease surveys have already adequately covered the area.

c. Seafloor Obstruction Surveys - Before operations involving mobile drilling rigs, pipeline-lay barges, and anchor-handling vessels can begin, it may be necessary to conduct a seafloor obstruction survey in order to locate existing pipelines and other potential hazards. This survey is not required if the data from other surveys are adequate to accomplish this purpose. Seafloor obstruction surveys for wells and platforms shall be run in an area at least 300 meters (980 feet) square with three equidistant primary lines and at least one cross line. Seafloor obstruction surveys for pipelines shall be run using the same pattern as that required for pipeline pre-installation surveys discussed in paragraph C.2.d. of this section.

d. Pipeline Pre-installation Surveys - The pattern for pipeline pre-installation surveys shall in include a line along the proposed pipeline route with an offset parallel line on either side spaced to coincide with the area that will be disturbed by the pipeline-lay barge anchors. Individual pipeline pre-installation surveys for lease and permit pipelines are not required in areas where other surveys have already adequately covered the area.

D. Shallow Hazards Reports

1. Introduction

An evaluation of data gathered during the shallow hazards survey and a synthesis with other available geological and geophysical information shall be included in a report prepared and signed by a geophysicist or geologist specializing in high-resolution geophysical interpretation.

Three copies of each shallow hazards report shall be submitted to the Regional Supervisor, Offshore Rules and Production (or the Regional Supervisor, Offshore Reserves and Development for unitized areas). The report shall be submitted with or in advance of the POE, POD/P, or pipeline application for which it was prepared. Operators are encouraged to combine shallow hazards reports with cultural resource reports (when required) since many of the requirements for these reports are similar. Shallow hazards reports are not required for seafloor obstruction surveys, as discussed in "Section III, paragraph C.2.c., of this NTL.

2. Report Contents

Shallow hazards reports shall include the following information:

a. A description of the area surveyed including lease number(s), block number(s), OCS lease area(s), and water depth.

b. A listing of the individuals involved in survey implementation and report preparation, and a brief description of the duties of each.

c. A discussion of the shallow hazards survey including (1) a brief description of the navigation system with a statement of its estimated accuracy for the area surveyed, (2) a brief description of all survey instrumentation including scale and sensitivity settings and tow depths for the magnetometer and side-scan sonar sensors, (3) a description or diagram of the survey vessel including vessel size, sensor configuration, navigation antenna location, cable lengths, and distances from sensors to navigation antenna, (4) vessel speed, (5) sea state and weather conditions, (6) a copy of the daily survey operations log, and (7) a description of survey procedures including a statement of survey and record quality, a comparison of data from survey line crossings, and a discussion of any problems which affected the ability of the geophysicist or geologist to identify and analyze shallow hazards in the survey area.

d. A map or separate maps at a scale of 1:12,000 and oriented to true north shall delineate (1) a navigation postplot of the survey area showing lease block lines, latitude-longitude reference coordinates, survey lines and directions, and survey shotpoints, (2) bathymetry, (3) shallow geologic structure, (4) deep geologic structure (from medium penetration profiler date), and (5) all anomalies such as side-scan sonar contacts, magnetic anomalies, and areas of shallow gas.

e. An assessment of the potential for shallow hazards within the survey area including but not limited to discussions of (1) general geological background, (2) previous oil and gas activity including wells, platforms, and pipelines, (3) bathymetry, (4) seafloor features including side-scan sonar contacts, (5) geological structure including faults, river channels, and karst areas, (6) shallow gas and possible abnormal pressure zones, (7) magnetic anomalies, and (8) unstable seafloor areas.

f. A listing of all magnetic anomalies including the corrected location by line and shotpoint, intensity, duration, and source of each (if known).

g. A summary of conclusions and recommendations supported by the survey data and analyses including a discussion of known or potential shallow hazards and areas to be avoided or that may require further investigations.

E. Original Data

All original survey data shall be maintained by the operator and made available upon request to the MMS at any time prior to lease termination.

IV. Requirements for Mitigation of Potential Shallow Hazards

A. POEs, POD/Ps, and Pipeline Applications

When review by the MMS of a shallow hazards survey and report and/or shallow hazards analysis indicates a potential hazard and operations are proposed within its immediate area, the operator shall have the following three alternatives:

1. Amend the POE, POD/P, or pipeline application to locate the site of operations to avoid the potential shallow hazard.

2. Demonstrate to the Regional Supervisor, Offshore Rules and Production (or the Regional Supervisor, Offshore Reserves and Development for unitized areas) that the use of special protective measures will minimize the risk to safe operations.

3. Establish, on the basis of further investigation using such equipment and techniques as deemed necessary by the Regional Supervisor, Offshore Rules and Production (or the Regional Supervisor, Offshore Reserves and Development for unitized areas) that such operations will not be adversely affected by the shallow hazard.

B. On-site Requirements

1. Prior to performing operations, all existing pipelines and other potential hazards located within 150 meters (490 feet) of the operation (including anchor patterns) shall be buoyed. In areas highly congested with pipelines or debris, a safe working area large enough to accommodate the proposed operations may be outlined with buoys in lieu of marking each hazard.

2. In addition, a plat with a minimum scale of 1:12,000 (1" = 1000') depicting the location of the proposed activity, all associated anchor patterns, and existing pipelines or other potential hazards in the area shall be prepared. Copies of this plat shall be provided to key personnel on all drilling rigs, derrick barges, pipeline-lay barges, and anchor-handling vessels associated with the operation.

Appendix C

Biological Opinions

United States Department of the Interior

MINERALS MANAGEMENT SERVICE
WASHINGTON, DC 20240

In Reply Refer To:
LMS-Mail Stop 644

[illegible] 1985

Memorandum

To: Director, U.S. Fish and Wildlife Service

From: Director, Minerals Management Service (Sgd) Wm. D. Bettenberg

Subject: Endangered Species Act Section 7 Formal Consultation on Proposed Outer Continental Shelf Oil and Gas Lease Sale 110 and a Currently Unnumbered Sale in, Respectively, the Central and Western Gulf of Mexico

On January 15, 1985, a memorandum from the U.S. Fish and Wildlife Service (FWS) Southeastern Region Office concurred with the Minerals Management Service's (MMS's) November 30, 1984, determination that there was no need to reinitiate Endangered Species Act section 7 formal consultation for Outer Continental Shelf (OCS) Oil and Gas Lease Sales 104 and 105 proposed for 1986 in the Gulf of Mexico. The FWS also agreed that the proposed lease sales did not represent a substantive modification of proposals considered in previous regionwide consultations on the potential effects of OCS leasing and exploration on endangered and threatened species in this region. These earlier consultations resulted in biological opinions issued on April 10, 1979, and June 30, 1982, the latter having been amended on October 25, 1982.

The MMS is currently preparing for proposed OCS Lease Sale 110 in the central Gulf of Mexico and a currently unnumbered sale in the western Gulf. These are tentatively scheduled, respectively, for April 1987 and an unspecified date later in the year. As was the case for the 1986 sales, the sales proposed for 1987 also do not substantively modify the proposals covered by the earlier FWS regionwide biological opinions. Neither has any significant new information become available that would alter the conclusions reached in the existing FWS regionwide biological opinions, nor have additional species been listed as endangered or threatened, or critical habitat designated, that would be affected by the proposed actions.

For the above reasons, we have determined that it will not be necessary to reinitiate section 7 formal consultation as part of our preparations for the proposed 1987 lease sales. This determination has been verbally agreed to in phone conversations between MMS and FWS regional staff. We now seek, through this memorandum, formal FWS written concurrence with our determination.

If you have any questions concerning this matter, please address them to Jackson E. Lewis, Minerals Management Service, Mail Stop 644, 12203 Sunrise Valley Drive, Reston, Virginia 22091 (Commercial telephone: 703-860-6461; FTS: 928-6461).

C-4

United States Department of the Interior
FISH AND WILDLIFE SERVICE
75 SPRING STREET, S.W.
ATLANTA, GEORGIA 30303

January 29, 1986

MEMORANDUM

TO: Director, Minerals Management Service, DOI, Washington, D.C.

FROM: Acting Regional Director, FWS, Atlanta, Georgia (AFA/SE)

SUBJECT: Section 7 Consultation on Outer Continental Shelf Oil and Gas Leasing and Exploration in the Gulf of Mexico

We have reviewed the information that was provided on the proposed Outer Continental Shelf leasing sale number 110 in the Central Gulf and a currently unnumbered sale in the Western Gulf of Mexico. We concur that these sales do not represent a substantive modification of the proposed actions considered in earlier regionwide consultations (April 10, 1979; June 30, 1982; and the October 25, 1982, amendment to the June 30, 1982, opinion).

Therefore, we concur that formal consultation for these sales need not be initiated at this time. However, the Minerals Management Service is reminded that formal Section 7 consultation must be initiated if new information reveals impacts on listed species or their habitats for these OCS sales that were not considered in this review, if those proposed OCS sales are subsequently modified, or if a new species is listed or critical habitat is designated which may be affected by these proposed OCS sales.

ADDRESS ONLY THE DIRECTOR
FISH AND WILDLIFE SERVICE

United States Department of the Interior

FISH AND WILDLIFE SERVICE
WASHINGTON, D.C. 20240

In Reply Refer To:
FWS/OES MMS-82-1

OCT 25 1982

MEMORANDUM

To: Director, Minerals Management Service

From: Chief, Office of Endangered Species

Subject: Amended Biological Opinion for the Lease and Exploration of Outer Continental Shelf Lands in the Gulf of Mexico Region

By memorandum received November 10, 1981, the Bureau of Land Management (BLM) and the Geological Survey (GS), now a part of the Minerals Management Service (MMS), requested the reinitiation of formal consultation with the U.S. Fish and Wildlife Service (FWS) under Section 7(a) of the Endangered Species Act to consider all of the operations pertaining to Outer Continental Shelf (OCS) oil and gas leasing and exploration in the Gulf of Mexico OCS Planning Area.

An original Section 7 consultation on the lease and exploration of OCS lands in this area occurred in 1979 with a biological opinion being rendered to BLM and GS April 10, 1979 (copy attached). Consultation was reinitiated on the basis of an extension of the boundaries of the Gulf Region as well as on an oilspill analysis for the Region.

A consultation team consisting of Wayne Milstead, Office of Endangered Species (OES), Team Leader; Bob Cooke, FWS, Region 4 Office, Atlanta, Georgia; and Jim Barkuloo, FWS, Panama City, Florida, was appointed and attended a meeting with representatives of MMS in New Orleans on December 2-3, 1981. The consultation team requested information on any new potential onshore facilities in the Region and an analysis of the probability of oilspills occurring as a result of the action. Since the information was not forthcoming and the 90-day period for consultation had run out, a memorandum was sent to MMS on March 4, 1982, requesting that formal consultation be delayed until the information requested was made available. On March 13, 1982, the information requested was received from MMS, but as a result of subsequent conversations with MMS personnel it was discovered that the oilspill analysis had been revised. Final, up-to-date oilspill information was received in OES on April 13, 1982, at which time the formal consultation period was resumed.

[Following submission of a biological opinion on June 30, 1982, the FWS felt that new information received on the potential impacts of this project on listed species was sufficient to necessitate a revision, resulting in this amended version.]

The following listed Endangered or Threatened species were considered during this consultation as being potentially affected by the action: bald eagle (Haliaeetus leucocephalus), brown pelican (Pelecanus occidentalis), loggerhead sea turtle (Caretta caretta), Kemp's (=Atlantic) Ridley sea turtle (Lepidochelys kempii), West Indian (Florida) manatee (Trichechus manatus) and its Critical Habitat, [American crocodile (Crocodylus acutus) and its Critical Habitat,] and whooping crane (Grus americana) and its Critical Habitat. [The status of other species included in the April 10, 1979, biological opinion has not changed substantially. The extension of the lease area and the oilspill risk analysis will not result in changes in the 1979 opinion for these species.]

The Gulf area involved in this consultation includes the outer continental shelf lands not presently under lease that are north of a line running east from approximately the U.S.-Mexican border on the coast at 26 degrees north latitude to 88 degrees west longitude where it jogs north 1 degree latitude, then east again 2 degrees west longitude to 86 degrees west longitude with another diversion south 2 degrees latitude to 25 degrees north latitude and finally east toward the Florida coast until a final jog north along 82 west degrees longitude intersects the Florida coast just south of Charlotte Harbor (Figure 1). This consultation considers the effect of all activities associated with the lease and exploration of lands within this area on listed Endangered and Threatened species under the jurisdiction of the FWS.

[A major change which brought about the reinitiation of the previous consultation was the addition of a "frontier" lease area off southwest Florida between 26 degrees and 25 degrees north latitude. In addition, new information on Gulf-wide OCS activities was provided in the form of an oilspill risk analysis for the development/production phase in the region. This opinion, therefore, concentrates on those species which are within or adjacent to this "frontier" area. Comments will generally reference the previous biological opinion of April 10, 1979, and the statements in that opinion stand unless new information necessitates additional comment or allows a change in any part of that opinion.]

Exploration of the OCS requires certain onshore facilities that might include office space, helicopter and fixed-wing aircraft facilities, boat docks, and support bases. There is an extensive history of intensive oil and gas activity in the Gulf of Mexico, and numerous onshore facilities have been established throughout the Region. The availability and necessity of onshore facilities appears to remain as they were at the time of our April 10, 1979, biological opinion, and it would seem unlikely that additional lease and exploration of the OCS in the Gulf Region will result in the development of additional onshore support facilities. Should the use of existing facilities be changed or additional onshore facilities be needed which may affect listed species or their habitats, consultation must be reinitiated.

Although not available for the 1979 consultation, an oilspill risk analysis has been provided for this reinitiation. It gives the percent probability that one or more spills of 1000 barrels or more will occur, from a variety of sources, during the life of the project and that they will strike various targets and/or land segments along the Gulf Coast within 3, 10, or 30 days after initiation of the spill. This analysis is based on activities that can be expected to be associated with the development and production phases of the project following lease and exploration, and this consultation is on the lease and exploration phases only. Probabilities are broken down into spills expected to result from three cumulative categories of events: (1) the proposed lease sale only, (2) the proposed sale plus existing leased OCS lands, and (3) the proposed sale plus existing leased lands, as well as oil imports moving through the lease area. The life of the proposal is considered to be 40 years. If the third category of events leading to oilspills that will strike various targets within 30 days (proposed sale, existing activities, and imported oil) is considered the worst case situation, some figures are very high. This is particularly true of land segments in the western Gulf where probabilities from the proposed lease alone are from 13 percent at Aransas County, Texas (whooping crane wintering range), to 67 percent at Saint Bernard Parish, Louisiana (a brown pelican nesting site); and if existing leased lands plus imported oil are included, these figures increase respectively to 51 percent and 93 percent.

Although the general statements and considerations provided for each species in the 1979 biological opinion are still appropriate, [the addition of a "frontier" area and] the introduction of oilspill data necessitates an additional consideration of potential impacts on some species. [The West Indian manatee, American crocodile, brown pelican, and loggerhead sea turtle are the species most likely to be impacted as a result of the extended lease area. Other limited species are considered here because of the potential for impacts as oil and gas activities increase throughout the Region.]

Bald Eagle (Haliaeetus leucocephalus)

The discussion in the 1979 biological opinion regarding the possible contamination of the bald eagle's food source by an oilspill is emphasized by the high probabilities of such spills reaching segments of the Texas and Louisiana coast in reasonable proximity to bald eagle nesting territories. It can be expected that bald eagles might be attracted to the area of a spill by dead and dying fish and birds as a food source and thereby consume oil adhering to prey species. Nevertheless, evidence from other species of birds suggests that adult birds may be able to tolerate the ingestion of fairly high concentrations of crude oil. Also, the direct effect of oil on plumage is perhaps not as significant a factor with bald eagles since adults, at least, tend to have minimal contact with the water from which they are taking prey.

However, the more important adverse impact of an oilspill on bald eagles would probably be on reproduction through contamination of eggs from adults carrying oil on breast feathers and feet.

Nesting territories are found in or near Refugio (land segment 6), Calhoun (land segment 7), Matagorda (land segment 8), and Brazoria (land segment 9) Counties, Texas, and the relatively high probabilities of oilspills striking these areas (13 percent, 24 percent, 45 percent, and 32 percent respectively) are of concern. Similarly, active bald eagle nesting in the Mississippi delta region of Louisiana from land segments 16 to 21, along with associated oilspill probabilities of 54 percent, 40 percent, 17 percent, 86 percent, 67 percent, and 31 percent respectively suggests a high level of threat to the recoverability of the species in the western Gulf Region. [The status of this species in the eastern and central Gulf Regions is essentially the same as discussed in the 1979 biological opinion.]

Brown Pelican (Pelecanus occidentalis)

Few brown pelican nesting sites remain in the western Gulf of Mexico. Three sites exist along the Texas coast, Pelican Island, Nueces County (land segment 5), and Second Chain of Island and Sundown Island, Calhoun County (land segment 7). Also, pelicans range over much of the Texas coast from land segment 4 (Kleberg County) north to land segment 8 (Matagorda County). Probabilities of oilspills resulting from the proposed sale striking land segments 5, 6, and 7 are 22 percent, 13 percent, and 24 percent respectively. These figures are increased to 44 percent, 51 percent, and 61 percent when oil from existing leased OCS lands and oil imports are included as a factor.

In Louisiana, only two small restored nesting colonies exist, one on Queen Bess Island, Jefferson Parish (land segment 18) and the other on North Island, Saint Bernard Parish (land segment 20). The probability of oilspills from the proposed lease activity striking these two segments is 17 percent and 67 percent respectively.

When the effects of existing leased OCS lands and imported oil is included, these probabilities increase to 69 percent and 93 percent. Such high values nearly assure that one or both of these two fragile nesting sites will be affected by one or more oilspills of 1000 barrels or more within 30 days after release over the 40 years of the project. Even though all these island nesting sites in Texas, as well as in Louisiana, might be partially protected from the direct impact of an oilspill in the open Gulf by seaward barrier islands, the wide-ranging nature of the birds when foraging would amplify the possibility of oil contamination. The most damaging effect of oil contamination on brown pelicans would be on reproduction. Due to the bird's feeding habits, it is reasonable to assume that adult brown pelicans might in fact avoid feeding in oiled waters because of the difficulty of their observing fish beneath the surface. But very small amounts of certain crude and refined oils applied to the surface of eggs cause high embryonic mortality or morphological abnormalities in a variety of avian species. If spills occurred during the nesting season of the brown pelican, oil can be transferred to eggs from feathers or feet of adults resulting in reduction in hatching rate. As with bald eagles, the impact of oilspills on the recoverability of brown pelicans in the Texas-Louisiana coastal region could be substantial. [The status of the brown pelican in the eastern Gulf Region is essentially the same as discussed in the 1979 biological opinion.]

Whooping Crane (Grus americana)

The wintering range of the entire reproducing wild population of the whooping crane exists along a stretch of Texas coast, including a portion of the Critical Habitat (Aransas, Calhoun, and Matagorda Counties), subject to probabilities of being impacted by one or more substantial oilspills of 13 percent, 24 percent, and 45 percent during the life of the proposed lease of these OCS lands. These figures increase to 51 percent, 61 percent, and 86 percent when activities on existing leased lands plus imported oil are added to the oilspill analysis.

These birds feed largely on crabs and clams in tidal flats and shallow bays and channels while wading, and oiled waters in these habitats could pose a considerable threat if a spill occurred between November and late April when the cranes are on their wintering grounds. Again, as with brown pelican nesting sites, this wintering habitat of whooping cranes is protected to some extent from oilspills in the open Gulf by barrier islands, but the loss of even a relatively small portion of a population, estimated to consist of approximately 75 individuals, could have a drastic impact on the continued existence of the species.

Sea Turtles

[Recent studies on the effects of petroleum on the development and survival of marine turtle embryos are inconclusive. The results of these studies indicate that oil remaining on the beach approximately one year after a spill did not cause significant mortality in sea turtle eggs, however, fresh crude oil deposited on top of sand can cause extensive mortality to incubating sea turtle eggs. More definitive information is needed to assess impacts of oiling on sea turtle nesting beaches.]

Loggerhead Sea Turtle - (Caretta caretta)

Loggerhead sea turtles nest on several barrier islands along the Gulf coast, in some cases in considerable numbers. The probabilities of an oilspill from all potential sources striking some areas of known loggerhead nesting sites within 30 days are relatively high. For instance, the figures for the Chandeleur Islands, Louisiana (segment 20), has a probability from all sources of 93 percent and Santa Rose Island, Florida (segment 24), has a probability of 36 percent. [The probability of oil reaching nesting beaches in the "frontier" lease area off Florida as a result of OCS leasing and exploration is near zero.]

Kemp's (=Atlantic) Ridley Sea Turtle - (Lepidochelys kempii)

Except for purported occassional nestings along the southern Texas coast, this species nests entirely along an approximately 14-mile stretch of Mexican coast.

Since 1978, the U.S. Fish and Wildlife Service has been involved in a project designed to return these turtles to nesting sites in the U.S. Eggs are collected in Mexico, transported to Padre Island National Seashore, and placed in artificial nests. After hatchlings move from these nests into the water, they are recaptured and raised in "head start" facilities until they are mature enough to be released into the Gulf. It is hoped that this procedure will result in turtles that are imprinted on Padre Island as a nesting site, and that they will return there when sexually mature at approximately 7 years of age. [The impacts of a fresh oilspill on nesting stages of the species would probably be significant if the oil hit the beaches during the nesting season.] The probability of a 1000 barrel or more oilspill striking some part of Padre Island within 30 days of its inception from the proposed sale only ranges from 5 percent to 19 percent, and when present activities are added these climb to 8 percent to 33 percent. Such probability figures are high enough to warrant concern.

West Indian (Florida) Manatee - (Trichechus manatus)

The manatee is confined to shallow coastal waters, bays, rivers, and inlets along both coasts of Florida, portions of which are designated as Critical Habitat. The probabilities of one or more oilspills of 1000 barrels or more occurring and striking coastal areas within the range of the manatee on the west coast of Florida within 30 days of release is 6 percent. For any one land segment in manatee range, the highest probability, 3 percent, is found adjacent to the Tampa Bay area. On the basis of this information, it would appear that oiling should not pose much of a threat to the manatee.

Boat traffic has been and remains a major threat to the species, and this was the primary topic of concern in the biological opinion of 1979. In this case, the potential hazard from boat traffic would of course derive from any additional boating activities associated with the lease and subsequent exploration for petroleum in the Gulf OCS.

[American crocodile (Crocodylus acutus)

The extension of the OCS lease area south to 25 degrees north latitude offshore Florida increases the potential for disturbance and impact on the crocodile. The lower Keys population within the National Key Deer Refuge would be within 20 nautical miles of the nearest lease tract offered. The nearest documented nesting population to the lease areas is located within Everglades National Park, approximately 30 nautical miles from the nearest lease tract. The oilspill risk analysis shows a 1 percent probability of oil reaching land in land segment 43 within 30 days, but the probability of it reaching Everglades National Park was less than 0.5 percent. Since the possibility of an oilspill is even less during exploration, and no new onshore facilities are anticipated, the April 10, 1979, biological opinion for the American crocodile is still valid. This includes the provision that "any development/production activities in or near the Cape Sable/Florida Bay area will require Section 7 consultation. At that time, further information will be necessary to determine the effect on the American crocodile. This information should include site specific transportation methods to be used, location of all onshore facilities associated with OCS activities, an oilspill trajectory study including current direction/velocity information, and other pertinent information." Although an oilspill risk analysis is now available, there may be a need for more site specific or refined information on oilspill trajectories in case of development/production.]

Conclusion, Advisory Statement, and Cumulative Effects

There are two areas of concern when considering potential affects of leasing and exploring OCS lands in the Gulf of Mexico on Endangered or Threatened species. One is the development of onshore facilities that are either support bases directly associated with exploration activities or marine terminals, refineries, gas processing plants, pipelines, etc. that are associated with subsequent development and production activities. Second is the chance that, if discoveries are sufficient and production occurs, oilspills of significant size may occur and impact listed species and/or their habitats.

In your memorandum of March 11, 1982, you stated that the existing support base at Port Manatee, Florida, is the most likely one to be used, but there is a 5 percent to 10 percent probability that Boca Grande or Key West, Florida, could be used as support bases. We take this to mean that no new support bases will be required for exploration activities resulting from the lease of OCS lands in the Gulf Region covered by this consultation, with the exception of the slight chance that Boca Grande and Key West might be used. Furthemore, it is assumed that all other types of facilities mentioned in this memorandum will be required only if development and production result from exploration in this Region.

It is also understood that the oilspill analysis provided for this consultation pertains only to the development and production phases on lands to be leased in the Region, plus the background of existing production along with the contributory effect of oil imported into the Gulf of Mexico. Therefore, as long as leasing and exploration activities utilize only existing onshore support facilities in the Gulf Region (not to include the use of Boca Grande and Key West, Florida), and as long as the probability of oilspills (of a magnitude large enough to be included in the oilspill analysis) occurring during the exploration phase is essentially zero, then it is my biological opinion that these activities are not likely to jeopardize the continued existence of the bald eagle, the brown pelican, the whooping crane, the loggerhead sea turtle, the Kemp's (=Atlantic) Ridley sea turtle, [the American crocodile,] and the West Indian (Florida) manatee or result in the destruction or adverse modification of the Critical Habitat of the whooping crane, [the American crocodile,] and the Florida manatee. However, should any additional onshore facilities be established along the Gulf Coast in support of exploration activities, particularly south of Tampa Bay, Florida (Port Manatee), then formal Section 7 consultation must be reinitiated. Such a request for consultation must include the following information:

(a) Location of the port to be used for operation;

(b) Routes or channels to be used by the vessels or aircraft and the relationships between these routes and listed species habitat or migration routes;

(c) Description of vessels to be used for support of OCS operations (design, speed, draft, and other pertinent information);

(d) Determinations of whether the vessels used for OCS oil and gas operations would have characteristics which would be more detrimental to manatees than those currently used in manatee habitat.

[(e) Refinement and update of oilspill risk analysis, with emphasis on southwest Florida.]

Even though the probability of one or more oilspills occurring and striking the southwest Florida coast is very small, our concern over the fragile nature of the Florida Bay area expressed in our April 1979 biological opinion continues. In this regard, we reiterate our statement about consulting on the establishment of any support bases along the coast south of Tampa Bay, Florida. We also advise extreme caution when considering any development plans that might feasibly contribute to an increased danger of oilspills in this south Florida area.

We also strongly recommend an investigation into the possible fate of oil from a spill once it is carried out of the Gulf around the southern tip of Florida by the Loop Current. Depending on the location of a spill and the existence and combination of wind and sea currents, it seems possible that oil from the Gulf might end up being deposited on the east coast of Florida under certain conditions.

In this opinion we have endeavored to address the direct (leasing and exploration of OCS lands) and indirect (oilspills and support facilities resulting from exploration) effects of the action as well as the interrelated (development and production phases, along with potential oilspills of the OCS program) and interdependent (pipelines, marine terminals, refinery, gas processing facilities, etc. that could result from development and production) aspects of the action. We have concluded that the direct and indirect actions are not likely to jeopardize the continued existence of the above listed species or result in the destruction or adverse modification of their Critical Habitats if the probability of oilspills from exploration are considered to be near zero and as long as existing support bases are sufficient to handle anticipated exploration activities. Consultation must be reinitiated if indirect actions (especially a need for new support bases) change or, if the interrelated and interdependent activities of development and production commence.

There remains for consideration, the cumulative effects of State and private actions in the Gulf Region that are reasonably certain to occur prior to completion of the Federal action which is the subject of this consultation. Since no specific information on such actions has been provided us by the Federal action agency to date, we reserve the right to make a supplementary comment on the potential effects of these projects (cumulative effects) after receiving a copy of the draft Environmental Impact Statement on this project.

The Minerals Management Service is reminded that Section 7 consultation must be reinitiated if new information reveals impacts on listed species or their habitats from this Federal project that were not considered in this opinion, if the proposed project is subsequently modified, or if a new species is listed or Critical Habitat is designated which may be affected by the proposed actions.

Attachment

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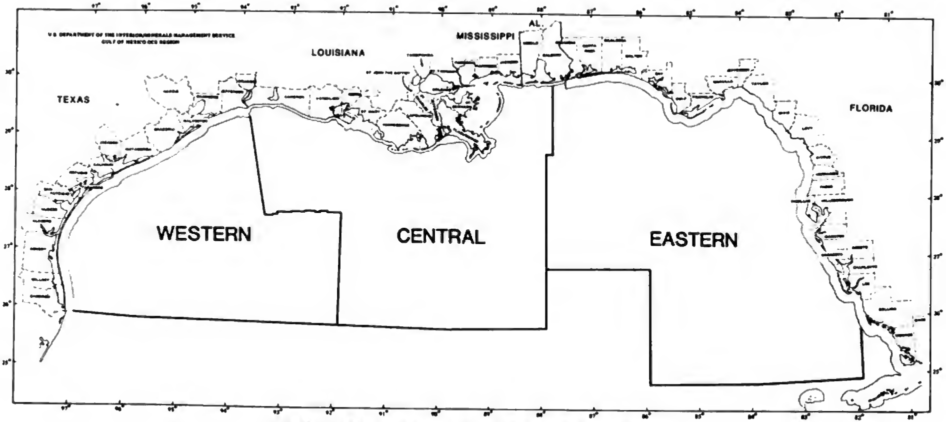
U.S. DEPARTMENT OF THE INTERIOR/MINERALS MANAGEMENT SERVICE
GULF OF MEXICO OCS REGION
TEXAS
LOUISIANA
MISSISSIPPI
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FLORIDA
WESTERN
CENTRAL
EASTERN

GULF OF MEXICO OCS PLANNING AREAS

Appendix D

Synopsis of Impacts from the 1985 Gulf of Mexico Hurricanes

I. PURPOSE

The purpose of this report is to show environmental and economic damages caused by the 1985 Gulf of Mexico hurricanes: Danny, Elena, Juan, and Kate (Figures D-1 and D-2). However, the report does not present a complete description of 1985 hurricane impacts since data are still being compiled and some may never be available. Information discussed generally represents preliminary estimates from respective contacts.

II. DESCRIPTION OF THE STUDY AREA

The 1985 Gulf of Mexico hurricanes primarily affected economic and environmental resources in the Central and Eastern Planning Areas and in State waters and coastal counties in Louisiana, Mississippi, Alabama, and Florida (Figure IV-1). In this report these areas will be referred to as the Central Gulf of Mexico area and the Eastern Gulf of Mexico area.

III. HISTORICAL OVERVIEW OF SELECTED HURRICANES UP TO 1980 IN THE GULF OF MEXICO

Hurricanes have always posed a seasonal threat to the people of the Gulf of Mexico coastal region. Damages resulting from these violent storms have been noted as far back as the Spanish explorations by Columbus in the late 1400's. Five unidentified Spanish ships carrying unknown cargo were destroyed during a 1766 hurricane in the Bay of St. Bernard (Galveston Bay). In 1778, 14 unidentified large British ships carrying lumber to Jamaica were destroyed in Pensacola Harbor by a hurricane (Coastal Environments, Inc., 1977). Indianola, Texas, was struck by a hurricane in 1875 which resulted in the destruction of three-quarters of the town; 176 lives were lost. Eleven years later Indianola was destroyed by another hurricane; the town was never rebuilt. In 1900, Galveston, Texas, was the location of the worst hurricane disaster in the history of Gulf of Mexico. Tidal surges were recorded at 15-20 ft (4.6-6.1 m). More than 3,600 homes were destroyed and 6,000 to 8,000 people lost their lives.

In recent years, hurricanes have had a great impact on offshore oil development in addition to posing threats to residents of coastal regions. Hurricane Camille (1969) caused 262 deaths and record tidal surges of 22.9 ft (6.9 m) in Mississippi. Three offshore platforms were affected; the first was completely destroyed, the second was severely damaged and removed from the offshore, and the third platform suffered damages but was repaired and reused in another area. The damage to these three platforms, plus 5,997 ft (1,828 m) of pipelines, exceeded $40 million.

Other hurricanes which have caused destruction to offshore development are as follows: Hurricane Hilda (1964) destroyed six platforms; Hurricane Carmen (1974) caused four pipeline breaks; Hurricane Eloise (1975) caused one pipeline break; and Hurricane Bob (1979) caused one pipeline break (DeWald, 1982).

IV. HURRICANE OVERVIEW FROM 1980-1985

Figure D-3 indicates the paths taken by hurricanes which occurred between the years 1980-1985. In addition to those hurricanes discussed above, several others are displayed.

Hurricane Allen (August 1980) with winds in excess of 150 mph, hit the southern coast of Texas, causing torrential rains and tornadoes. An estimated 200,000 people evacuated their homes and at least 100 deaths, including 87 in the Caribbean and 13 in a helicopter accident offshore Louisiana, occurred as a result of the hurricane.

Extensive damage from Hurricane Alicia was estimated at $1 billion (August 1983). The hurricane grew stronger as it approached the Texas coast with winds recorded at 115 mph. Alicia came ashore in the Galveston/Houston area on August 18. Twenty-one deaths were attributed to the hurricane.

Hurricane Barry (August 1983) harrassed resorts along the Texas coast before it hit Mexico and dispersed. The storm first hit Puerto el Mezquital, Mexico, which is about 30 miles south of Brownsville, Texas, crossed the Laguna Madre, and struck Santa Teresa, a small fishing village. Hurricane Barry was downgraded to a tropical storm upon landfall. Evacuation shelters, however, were set up along the Texas coast before the storm hit Mexico.

Tropical Storm Bob (July 1984) hit the Florida coast in the vicinity of Naples/Ft. Myers with 50 mph winds and heavy rains. Two islands, Sanibel and Marco, were isolated from the mainland for hours. No injuries were reported

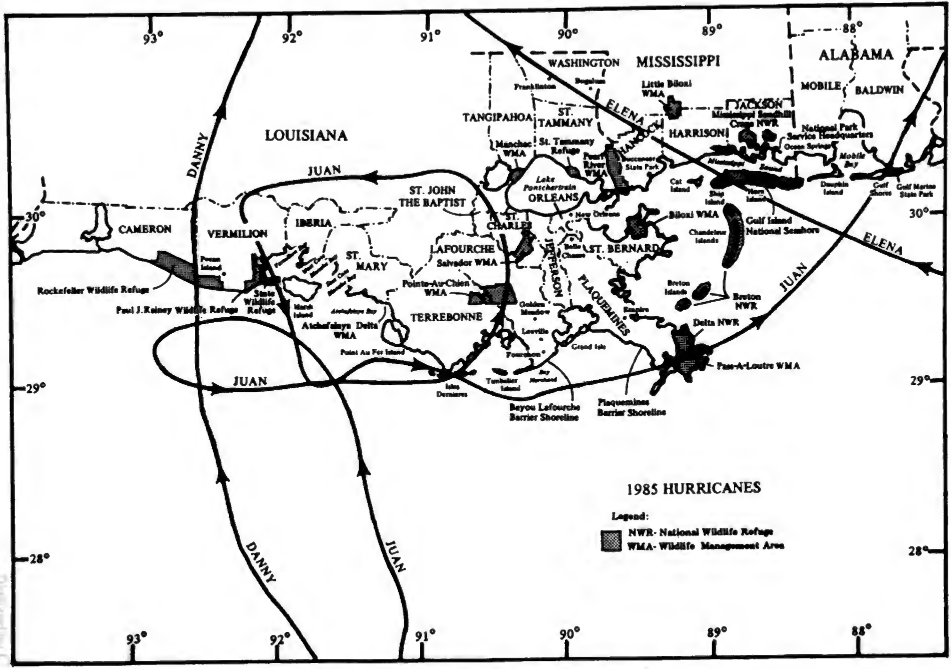


Figure D-1. 1985 Hurricanes: Danny, Elena, Juan, and Kate

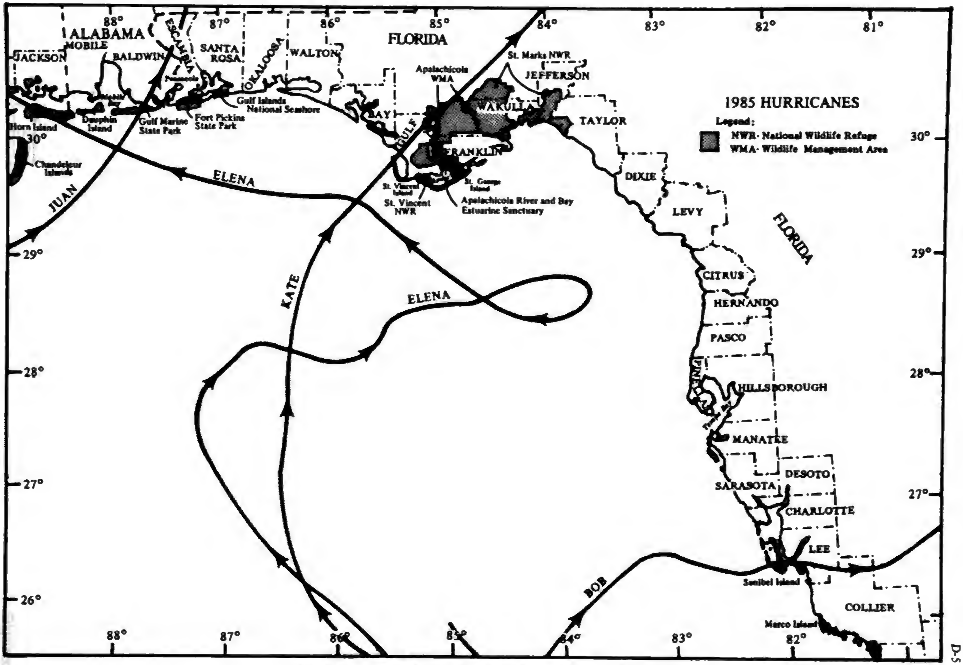
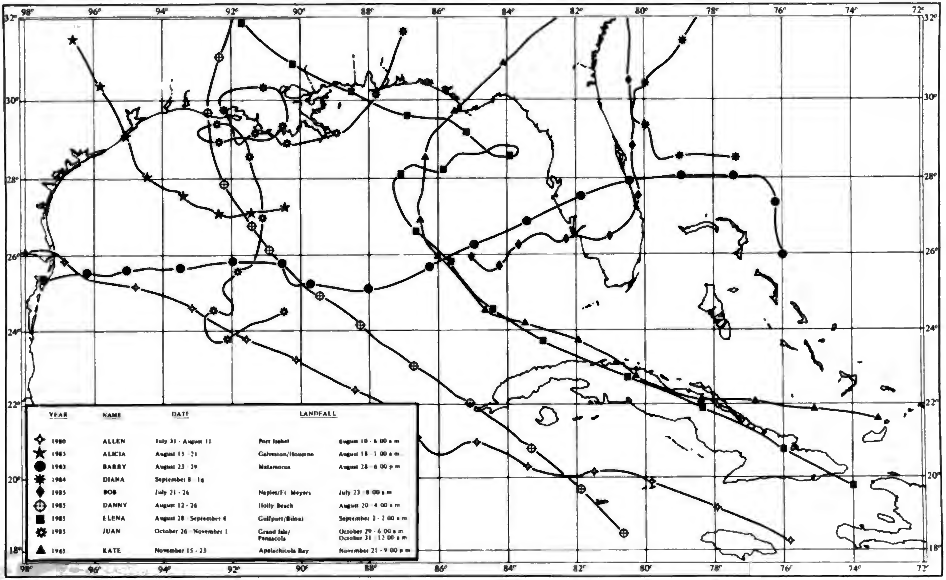


Figure D-2. 1985 Hurricanes: Elena, Juan, Kate, and Bob


98° 96° 94° 92° 90° 88° 86° 84° 82° 80° 78° 76° 74° 72°
32° 30° 28° 26° 24° 22° 20° 18°
YEAR NAME DATE LANDFALL
1980 ALLEN July 31 - August 11 Port Isabel August 10 - 6:00 a.m.
1983 ALICIA August 15 - 21 Galveston/Houston August 18 - 1:00 a.m.
1983 BARRY August 23 - 29 Matamoros August 28 - 6:00 p.m.
1984 DIANA September 8 - 16
1985 BOB July 21 - 26 Naples/Ft. Meyers July 23 - 8:00 a.m.
1985 DANNY August 12 - 26 Holly Beach August 20 - 4:00 a.m.
1985 ELENA August 28 - September 4 Gulfport/Biloxi September 2 - 2:00 a.m.
1985 JUAN October 26 - November 1 Grand Isle/Pensacola October 29 - 6:00 a.m. October 31 - 12:00 a.m.
1985 KATE November 15 - 23 Apalachicola Bay November 21 - 9:00 p.m.

GULF OF MEXICO HURRICANES 1980 - 1985

Figure D-3.

and only minor damage resulted to properties along the coast. Evacuation was not advised by the Division of Public Safety. During a 24-hour period, 11 inches of rain was recorded on Marco Island.

The southwest coast of Louisiana was hit by Hurricane Danny (August 1985) with gusts of winds reaching 100 mph. Flash floods, tornadoes, and power failures resulted which forced hundreds of people from low-lying homes. Total rainfall did not exceed 10 inches. The storm did not organize into a hurricane until just before landfall resulting in minimal onshore damage. No deaths resulted from the storm.

The evacuation of more than 500,000 people from Louisiana to Florida was the result of Hurricane Elena (September 1985). When Elena finally came ashore near Biloxi, Mississippi, her intensity decreased promptly. Although she caused millions of dollars worth of property damage, no deaths or serious injuries resulted. Winds were recorded up to 125 mph and at least 10 tornadoes were sighted. Over 110,000 homes and businesses were left without power.

Hurricane Juan (October/November 1985) intensified so quickly that the offshore oil and gas industry was unable to evacuate personnel on many rigs and platforms. As a result, a massive rescue of more than 140 people was performed by the U.S. Coast Guard. When the legs collapsed on a Penrod 61 drilling rig, 43 people evacuated into escape capsules; however, one capsule swamped which resulted in the death of one crewman. By October 31, Hurricane Juan had come within 60 miles of New Orleans. Eight lives were lost, fifty thousand homes were flooded, and an estimated $1 billion was the result of this storm. Finally, on November 1, tropical storm Juan left Louisiana and slowly drifted toward Alabama.

Hurricane Kate (November 1985) was the first November storm to hit the U.S. coast in 50 years. About 100,000 people left their homes before the storm hit the Florida panhandle. Sixteen people, including 10 in Cuba, lost their lives. Kate's winds were recorded at 75 mph and up to 8 inches of rain fell in some areas. Approximately 30,000 homes and businesses were powerless after the storm.

V. IMPACTS OF THE 1985 GULF COAST HURRICANES

A. CENTRAL GULF

1. Environmental Losses

a. Shorelines

Hurricanes and winter storms are major contributors to the destruction of Louisiana's barrier islands. High wave energy and the associated storm surges erode the land areas, particularly the shorelines. Because of the instability of the islands, major changes can occur.

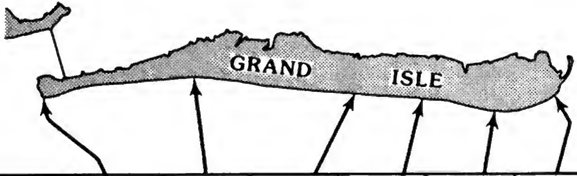
During Hurricane Danny, Terrebonne Parish barrier islands received the most damage. Waves and storm surge eroded 10%-15% of the Isles Dernieres' land area and cut multiple tidal channels through the barrier island area; however, because of the Terrebonne Parish Barrier Island Restoration Project, breaching and tidal inlet formation at the eastern end of Isles Dernieres were prevented. A major tidal inlet was cut through Timbalier Island at an oil and gas access canal and another through the eastern end of the island. Beaches at Grand Isle were seriously eroded. East of Grand Isle, 20-40 feet of shoreline eroded and several large breaches through the shoreline occurred where canals had been dredged in the back barrier wetlands (Louisiana Geological Survey, 1985).

Hurricane Elena caused severe coastal erosion and land loss along the Chandeleur Islands. Approximately 20% of the total island area was removed by the storm. On many parts of the islands, vegetation was stripped and major dune fields were severely damaged. The northern end of the island near the lighthouse was partially destroyed, and many tidal channels were cut through the northern quarter of the island (Louisiana Geological Survey, 1985).

The third hurricane to hit Louisiana's coast in 1985 was Hurricane Juan. It was the most destructive as far as coastal erosion and land loss are concerned. Beaches along the entire coast eroded 20-100 ft as a result of long-lasting, high tidal surges and storm waves. Channels were widened and several new inlets were created along the barrier islands which were devegetated in some areas (Louisiana Geological Survey, 1986). Figure D-4 shows cumulative beach erosion due to 1985 hurricanes at Grand Isle, Louisiana. Figure D-5 is a summary of the 1985 hurricane erosion in Louisiana as a result of Hurricanes Danny, Elena, and Juan.

In an attempt to respond to coastal erosion and land loss in coastal Louisiana (rates are exceeding 50 square miles per year), the Louisiana Geological Survey (LGS) has been charged with developing and administering a 10-

HURRICANE BEACH EROSION AT GRAND ISLE

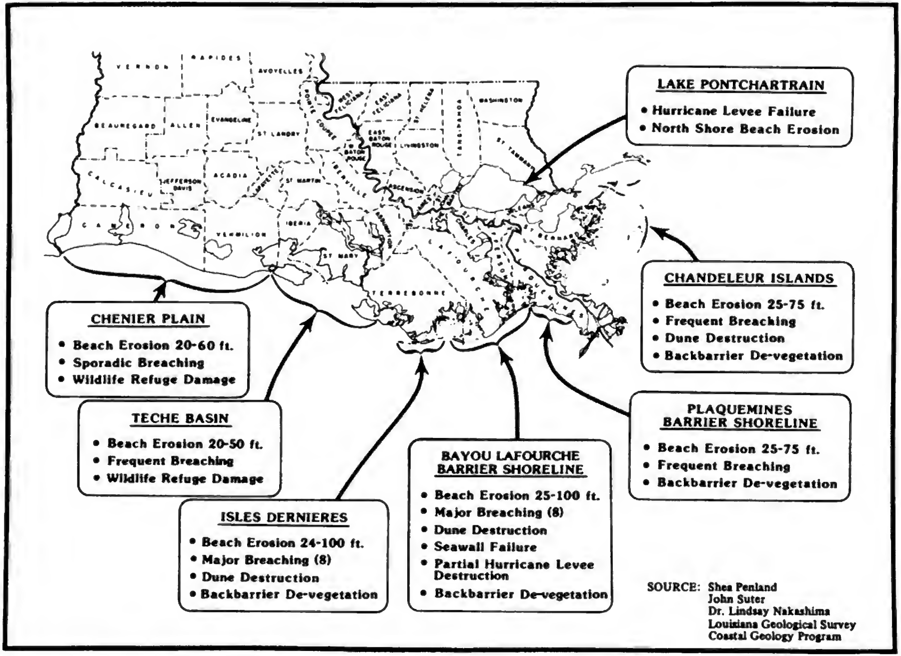


DANNY	-56 ft.	-30 ft.	-66 ft.	-64 ft.	-87 ft.	-28 ft.
ELENA	-21 ft.	-112 ft.	-40 ft.	-3 ft.	-30 ft.	-23 ft.
JUAN	-24 ft.	+40 ft.	+20 ft.	-5 ft.	0 ft.	+10 ft.
TOTAL	-101 ft.	-102 ft.	-86 ft.	-72 ft.	-117 ft.	-41 ft.

August 1, 1985 - Prestorm Survey
August 14, 1985 - Hurricane Danny Impact
August 17, 1985 - Post-Danny Survey
September 2, 1985 - Hurricane Elena Impact
September 3, 1985 - Post-Elena Survey
October 28-29, 1985 - Hurricane Juan Impact
November 6, 1985 - Post Juan Survey

SOURCE: Dr. Lindsay Nakashima
Louisiana Geological Survey
Coastal Geology Program

Figure D-4. Cumulative beach erosion due to 1985 hurricanes at Grand Isle, Louisiana



SOURCE: Shea Penland
John Suter
Dr. Lindsay Nakashima
Louisiana Geological Survey
Coastal Geology Program

Figure D-5. Summary of the 1985 hurricane impact in coastal Louisiana as a result of Hurricanes Danny, Elena, and Juan year, two-phase Coastal Protection Master Plan (Penland et al., 1986). Phase I calls for implementation of barrier island and shoreline restoration projects which are designed to slow erosion of barrier islands and mitigate the destruction by hurricanes. LGS believes the most cost-effective, proven methods for coastal protection are barrier island restoration and beach nourishment techniques combined with revegetation. During Phase II, offshore sand deposits will be used to periodically nourish the barrier islands and beaches. Vegetation and sand fencing will be used to help stabilize the dune fields (Penland et al., 1986). Louisiana shoreline and barrier island restoration costs are shown in Figure D-6.

b. Wildlife and Fisheries

Impacts of Hurricane Danny on wildlife in the State of Louisiana were summarized as follows: Alligator nests and eggs were destroyed or flooded throughout most of the brackish and intermediate marshes from Pecan Island to the mouth of the Pearl River, as well as in the fresh marshes northeast of Pecan Island and north of Vermilion Bay, West Cote Blanche Bay, East Cote Blanche Bay, and Atchafalaya Bay. Deer on Marsh Island were severely impacted with a loss of up to 50% of the population. Some unknown quantity of deer was lost from State Wildlife and Paul J. Rainey Refuges. In addition, deer were lost from Point au Fer Island. Thousands of nutria and muskrat carcasses were found in Vermilion and West Cote Blanche Bays. Many nutria, raccoons, rabbits, and clapper rails were lost from State Wildlife Refuge and Marsh Island. It was estimated that 60%-70% of the nutria population on Marsh Island was lost. Habitat damages were extensive but have not yet been fully assessed. In the Marsh Island impoundment, a key waterfowl management area in south Louisiana, all vegetation except wiregrass (*Spartina patens*) was lost. Vegetation was burned from high salinity water on the north side of the Intracoastal Canal north of Vermilion Bay and along East and West Cote Blanche Bays and there was also damage to the Atchafalaya Delta Wildlife Management Area (Tarver, 1985a).

Hurricane Juan adversely affected the Louisiana shrimp industry. It hit the Louisiana coast at historically the most productive time of the year for shrimping but boats stayed at port because of rough seas. Considerable debris and detritus were deposited on the shrimping grounds, resulting in losses to fishing gear and a loss of fishing time. The storm dispersed the population of shrimp, caused premature immigration, resulted in some shrimp mortalities, and resulted in a decrease in shrimp landings (Chantry, 1986).

Ninety percent of the Alabama oyster resources were lost as a result of Hurricane Elena. All major reefs, Cedar Point, Buoy, and Kings Bayou were impacted. The most productive reef, Cedar Point Reef (Mobile County), was virtually destroyed. Estimates were that restoration of 1,184 acres of reef area by planting adequate cultch material should result in replacement of the lost oyster resources within a period of 1.5-2.0 years, providing adequate spat set occurs (Tatum, 1985).

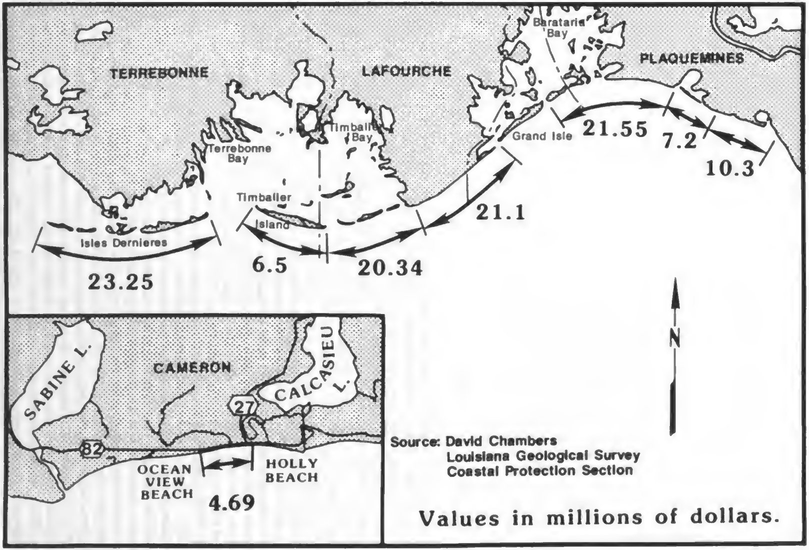
Damage estimates of the 1985 hurricanes off the Mississippi coast resulted in the death of approximately 10,000 marine birds (primarily eastern kingbirds, oven-birds, rails, herons, and egrets) in the vicinity of Horn Island and in a massive nutria kill which probably took place at Cat Island. Additionally, many large pine and hardwood trees were felled by the hurricanes in the vicinity of the National Park Service headquarters at Ocean Springs, Mississippi (Thomas, 1986).

2. Economic Losses

a. Oil and Gas Industry

Offshore losses to the oil and gas industries were extensive. Bright (1985) reported that a Pennzoil 6-inch pipeline at South Pass Block 78 broke three times during the 1985 hurricanes, resulting in estimated repair costs of $800,000 from Hurricane Juan and $1,600,000 from Hurricane Elena. Wallis (1985) estimated $36,000 for replacement of three Southern Natural Gas meter station sheds and $5,000,000 to replace and put back in operation an 18-inch pipeline at South Pass Block 60. Linton (1985), with Chevron Pipeline Company, estimated that Hurricane Juan resulted in a $1,000,000 mudslide pipeline break at West Delta Block 109 and in a $500,000 mudslide pipeline break at South Pass Block 78. Other Chevron Pipeline Company replacement/repair cost estimates for Louisiana onshore and offshore facilities as a result of Hurricane Juan includes: $368,800 for an oil treatment terminal at Main Pass Block 69; $287,000 for a Fourchon oil treatment terminal; $220,000 for an oil storage facility at Bay Marchand; $4,000 for a business office/shop at Leeville; $38,000 for an oil storage facility at

LOUISIANA SHORELINE AND BARRIER ISLAND RESTORATION COSTS



Source: David Chambers
Louisiana Geological Survey
Coastal Protection Section

Values in millions of dollars.

Figure D-6

Empire; $83,000 for West Delta tank battery; and $81,000 for personnel evacuation. Other damages resulting from the 1985 hurricanes are shown in Tables D-1 through D-4.

b. Vessel Casualties

Table D-4 represents vessel casualty information. As is indicated, seven deaths and nine injuries resulted from Hurricane Juan; none occurred with Elena, Danny, and Kate. Almost $9,000,000 and $1,000,000 in damage resulted from Hurricanes Elena and Danny, respectively. Submission of accident reports are required (46 CFR 40.05) when there is a loss of life, personal incapacitation beyond 72 hours, or an excess of $25,000 in damages.

c. Seafood Industry

The seafood industry suffered total damages in excess of $54,000,000 as a result of the 1985 hurricanes (Dawley, 1986). In Louisiana, Hurricane Danny damaged one seafood plant and one vessel, destroyed another plant and vessel, and damaged a seafood industry machine shop with a total cost estimate of $125,300. Hurricane Juan caused damages in Louisiana to 49 seafood plants and 8 vessels as well as the destruction of 3 vessels. This , with industry related damage, resulted in losses of $3,143,000 (Simpson, 1986). In Mississippi, Hurricane Elena damaged 30 seafood plants, and destroyed another, damaged 8 vessels, caused considerable plant and equipment damage to 3 local shipyards, and caused significant industry related damage which resulted in total damage estimates of $2,386,500. In addition, Tatum (1985) requested $1,492,088 in disaster funds to be used in replanting three very productive oyster reefs in their coastal area. The economic loss from the 1985 hurricanes to the Alabama oyster industry was $48,000,000.

d. Wildlife Facilities and Parks

The Louisiana Department of Wildlife and Fisheries summarized hurricane impacts on Louisiana's wildlife refuges and management areas (WMA's) as folows: Hurricane Juan damaged the Pass-A-Loutre WMA headquarters and destroyed equipment there in the amount of $17,054; damaged the Salvador WMA headquarters, destroyed equipment, and damaged a levee and water control structure with a cost estimate of $73,000; and damaged the Pointe-Au-Chien WMA headquarters, destroyed equipment, and damaged levee and water control structures in the amount of $539,797. Damage cost estimates at the Marsh Island Refuge totaled $13,346,140 for equipment replacement, equipment repairs, levee and water control structure repairs, and for miscellaneous repairs including the replacement of boundary signs and lost lumber. Losses at the Atchafalaya Delta WMA for damage to the generator and storage sheds, equipment replacement, and loss of shell on a ring levee totaled $32,400. At the State Wildlife Refuge, the cost estimate was $918,840 for headquarters repairs, levee and water control structure repairs, and miscellaneous damage repair. Levee and water control structure repairs, along with some miscellaneous repairs, were estimated at $13,898,000 at Rockefeller Wildlife Refuge. At St. Tammany Refuge the cost estimate was $1,161,000 for levee and water control structure repairs. Restoration of the levee shoreline at the Manchac Management Area was estimated at $1,650,000 (Tarver, 1985b).

Thomas (1986) reported on the 1985 hurricanes impacts to the Gulf Islands National Seashore. At Horn Island, Hurricane Elena damaged National Park Service facilities. It destroyed the boat pier, ten 4' x 10' sections of galvanized corrugated sheet metal roofing on the compound pavillion, 30 square feet of roofing shingles on the residence building, 350 square feet of roofing shingles from the generator building, and caused other minor damages for a total repair cost of $30,625. The Ship Island operation required $100,662 in total estimated damages and repair costs. This included repairing the snack bar, ranger storage room, bunkhouse kitchen, ranger residence, bunkhouse residence, and miscellaneous items. Davis Bayou total estimated costs was $99,700 for repairs/replacements at the campground area, day use area, visitor center area, maintenance area, public boat dock, and other facilities.

At Buccaneer State Park in Waveland, Mississippi, losses from Hurricane Elena were estimated at $22,000 due to loss of business over the Labor Day weekend, damage to five skylights, outdoor carpet, and cleanup costs (Richardson, 1986). Repair/replacement costs at the Mississippi Sandhill Crane National Wildlife Refuge (NWR) in Gautier, Mississippi, from Hurricane Elena totalled over $4,400. This included $2,000 on the Gautier pen observation tower, $500 on the office/visitor center roof, $300 on the pen fence, $200 for a jeep windshield, $600 on a truck fender and hood, $500 on a volunteer's trailer, and $300 to repair the broken leg of a Florida sandhill crane. Other damages, with no cost estimates, included downed timber and road and culvert damage (Chandler, 1985).

Table D-1

Pipeline Damages from Hurricane Juan in 1985
October 30 through November 2, 1985

	Company	Location (Area and Block)	Size/Type
1.	Chevron U.S.A. Inc.	South Pass 57B to South Pass 77A	8" oil
2.	Chevron U.S.A. Inc.	South Pass 57B to South Pass 77A	10" oil
3.	Chevron U.S.A. Inc.	South Pass 77C to South Pass 77A	10" oil
4.	The (Chevron Operator) Texas Pipeline Co.	West Delta 109A to shore	8" oil
5.	Pennzoil Co.	South Pass 78A to 8" SSTI[1] West Delta 109	6" oil
6.	MOBIL OIL EXPLORATION & PRODUCING SOUTHEAST INC.	Eugene Island 51B to Eugene Island 21 (3 miles)	12" oil
7.	Southern Natural Gas Co.	South Pass 60B to Main Pass 62 (26" SSTI)	18" gas
8.	Texaco Inc.	South Pass 37B to South Pass 37C	6" oil
9.	Kerr-McGee Corporation	Ship Shoal 33B to Ship Shoal 28 D-1 Platform	4" oil
10.	ODECO Oil & Gas Co.	South Timbalier 86A to South Timbalier 63 manifold - Platform A	10" gas
11.	ODECO Oil & Gas Co.	South Pelto 19 OBM[2] to South Pelto 12 Well Jacket #12	2" gas lift
12.	ODECO Oil & Gas Co.	South Pelto 19 OBM to South Pelto 19 Well Jacket #21	2" gas lift
13.	ODECO Oil & Gas Co.	South Pelto 19 OBM to South Pelto 19 Well Jacket #22	2" gas lift
14.	ODECO Oil & Gas Co.	South Pelto 19 OBM to South Pelto 19 Well Jacket #25	2" gas lift
15.	ODECO Oil & Gas Co.	South Pelto 19 OBM to South Pelto 19 Well Jacket #6	3 1/2" gas lift
16.	ODECO Oil & Gas Co.	South Pelto 19 OBM to South Pelto 20 Well Jacket #24	2 3/8" gas
17.	ODECO Oil & Gas Co.	South Pelto 19 OBM to Cocodrie	8" oil
18.	ODECO Oil & Gas Co.	South Pelto 19 OBM to Transco Sales	6" gas
19.	ODECO Oil & Gas Co.	South Pelto 19 OBM to Flare	6" gas
20.	ODECO Oil & Gas Co.	Ship Shoal 114 SOB[3] to South Pelto 19 OBM	8" oil
21.	ODECO Oil & Gas Co.	South Pelto 12A Platform to South Pelto 19 OBM	4" oil
22.	ODECO Oil & Gas Co.	South Pelto 19 Well Jacket #6 to South Pelto 19 OBM	3" oil
23.	ODECO Oil & Gas Co.	South Pelto 19 Well Jacket #6 to South Pelto 19 OBM	3" oil
24.	ODECO Oil & Gas Co.	South Pelto 19 Well Jacket #6 to South Pelto 19 OBM	3" oil
25.	ODECO Oil & Gas Co.	South Pelto 20 Well Jacket #24 to South Pelto 19 OBM	3" oil
26.	ODECO Oil & Gas Co.	South Pelto 20 Well Jacket #24 to South Pelto 19 OBM	3" oil
27.	ODECO Oil & Gas Co.	South Pelto 19 Well Jacket #14 to South Pelto 19 OBM	3" oil
28.	ODECO Oil & Gas Co.	South Pelto 19 Well Jacket #21 to South Pelto 19 OBM	2" oil
29.	ODECO Oil & Gas Co.	South Pelto 19 Well Jacket #21 to South Pelto 19 OBM	2" oil
30.	ODECO Oil & Gas Co.	South Pelto 19 Well Jacket #22 to South Pelto 19 OBM	3" oil
31.	ODECO Oil & Gas Co.	South Pelto 19 Well Jacket #22 to South Pelto 19 OBM	3" oil
32.	ODECO Oil & Gas Co.	South Pelto 20 Well Jacket #6 to South Pelto 19 OBM	3 1/2" oil
33.	ODECO Oil & Gas Co.	South Pelto 19 Well Jacket #25 to South Pelto 19 OBM	3 1/2" oil
34.	ODECO Oil & Gas Co.	South Pelto 19 Well Jacket #25 to South Pelto 19 OBM	3 1/2" oil
35.	ODECO Oil & Gas Co.	South Pelto 19 Well Jacket #29 to South Pelto 19 OBM	4 1/2" oil
36.	ODECO Oil & Gas Co.	South Pelto 19 Well Jacket #35 to South Pelto 19 OBM	4 1/2" oil
37.	ODECO Oil & Gas Co.	South Pelto 20 Well Jacket #28 to South Pelto 19 OBM	4 1/2" oil
38.	ODECO Oil & Gas Co.	South Pelto 20 Well Jacket #28 to South Pelto 19 OBM	4 1/2" oil
39.	ODECO Oil & Gas Co.	South Pelto 19 Well Jacket #33 to South Pelto 19 OBM	4 1/2" oil

Table D-1. Pipeline Damages from Hurricane Juan in 1985 (continued)

	Company	Location (Area and Block)	Size/Type
40.	ODECO Oil & Gas Co.	South Pelto 19 Well Jacket #33 to South Pelto 19 OBM	4 1/2" oil
41.	ODECO Oil & Gas Co.	South Pelto 12 Well Jacket #4 to South Pelto 19 OBM	4 1/2" oil
42.	ODECO Oil & Gas Co.	South Pelto 12 Well Jacket #4 to South Pelto 19 OBM	4 1/2" oil
43.	ODECO Oil & Gas Co.	South Pelto 20 Well Jacket #9 to South Pelto 19 OBM	3 1/2" oil
44.	ODECO Oil & Gas Co.	South Timbalier 86 Well No. 1 to South Timbalier 86A	4" abandoned
45.	ODECO Oil & Gas Co.	South Timbalier 86 Well Nos. 12 & 19 to South Timbalier 86A	4" bulk gas
46.	ODECO Oil & Gas Co.	South Timbalier 86 Well Nos. 12 & 19 to South Timbalier 86A	4" bulk gas
47.	ODECO Oil & Gas Co.	South Timbalier 86 Well No. 23 to South Timbalier 86A	3" bulk gas
48.	ODECO Oil & Gas Co.	South Timbalier 86 Well No. 24 to South Timbalier 86A	4" bulk gas
49.	ODECO Oil & Gas Co.	South Timbalier 86 6" SSTI to South Timbalier 63A	6" oil
50.	ODECO Oil & Gas Co.	South Timbalier 86A to South Timbalier 86C	2" gas lift
51.	ODECO Oil & Gas Co.	South Timbalier 86A to South Timbalier 86B	2" gas lift
52.	ODECO Oil & Gas Co.	South Timbalier 86A to South Timbalier 86 Flare	6" flare gas
53.	ODECO Oil & Gas Co.	South Timbalier 86A to South Timbalier 86 Well Nos. 12 & 19	4" abandoned
54.	ODECO Oil & Gas Co.	South Timbalier 86B to South Timbalier 86A	6" bulk oil
55.	ODECO Oil & Gas Co.	South Timbalier 86B to South Timbalier 86A	6" bulk oil
56.	ODECO Oil & Gas Co.	South Timbalier 86B to South Timbalier 86A	3" test line
57.	ODECO Oil & Gas Co.	South Timbalier 86C to South Timbalier 86A	6" bulk oil
58.	ODECO Oil & Gas Co.	South Timbalier 86C to South Timbalier 86A	3" test line
59.	ODECO Oil & Gas Co.	South Timbalier 86 4 SSTI to South Timbalier 86 Well No. 24	4" bulk oil
60.	Placid	Eugene Island 199 Well No. 1 to Eugene Island 199A	3" gas

[1] SSTI - subsea tie-in
[2] OBM - ODECO/Burmah/Mobile
[3] SOB - SOHIO/ODECO/Burmah

Source: Torres, 1986.

Table D-2

Spills from 1985 Hurricanes

Location Area/Block	Date	Type Event	Amount Spilled
Hurricane Danny			
South Timbalier	8/16	Equipment malfunction	2 bbls
Hurricane Elena			
South Pass 78A	9/1	Pipeline Spill	10 bbls
Chandeleur Area	9/4	Equipment Malfunction	66 bbls
Hurricane Juan			
South Pass 37B	10/28	Pipeline Spill	1 bbl
Bayou Lafourche	10/29	No Details	5 bbls
Morgan City (onshore)	10/29	No Details	10 gallons deisel
South Timbalier 151	11/1	Pollution Spill Damaged Wellhead	7.7 bbls
Ship Shoal 33	11/6	Pipeline Spill	3 bbls
Eugene Island 51A	11/9	Pipeline Spill	50 bbls
Lake Barre	10/31	No Details	195 bbls
Caillou Island	10/31	Pipeline Spill	15 bbls
Hurricane Kate			
South Pass 78A	11/22	Pipeline Spill	15 bbls

Sources: Rankin, 1985a.
Torres, 1986.
MMS Events File.
MMS Quarterly Report.
USCG, MPIR File, 1986.

Table D-3

Damage to Production Platforms from Hurricanes
Juan, Elena, and Danny

Operator	Location (area/block)	Damage
Hurricane Juan		
ODECO Oil and Gas Company	South Timbalier 86A	Platform capsized
ODECO Oil and Gas Company	South Pelto 19	OBM complex facilities damaged - No. 2 well undertook water knocked over
ODECO Oil and Gas Company	Ship Shoal 114	Gaslift line lost, casing leaked
MOBIL OIL EXPLORATION & PRODUCING, SOUTHEAST INC.	Ship Shoal 72	Hit by barge
Hurricane Danny		
Atlantic Richfield Company	Eugene Island 174 Platform Nod. 3 and 3D	60" caisson and Well No. 3 resting on seafloor
ODECO Oil and Gas Company	Eugene Island 95	189' x 18' four-pile structure resting sideways
Texaco Inc.	South Marsh 11 Platform No. 4	Caisson Well No. 4 bent at wellhead approximately 10-15' below water surface
Shell Offshore, Inc.	Eugene Island 128 and 116	Damage to well structures, pipelines, gas lifts, and headers
Elf Aquitaine, Inc.	Vermilion 153	Caisson Nos. 1 and 2 disappeared
Hurricane Elena		
Exxon Corporation	Destin Dome 284	Rig moved off location - eight joints of marine riser and tower marine riser package lost, then recovered
Exxon Corporation	Mobile 868	Damage to rotary beams and rotary drive system
Texaco, Inc.	Mobile 1006	Well No. 1 blowout preventer stack bent over
Anadarko Production Company	Chandeleur 18	Condensate hose broken
ODECO Oil and Gas Company	Ship Shoal 114	Wellhead not visible - rig moved over wellhead

No damage was reported due to Hurricane Kate.

Source: Rankin, 1985b.
USCG, Lohfstedt, Cole, 1986.

Table D-4

Reported Vessel Casualties in the Gulf of Mexico Attributable to Hurricanes

Name	Type	Death/ Injury	Result	Cost
Hurricane Juan				
Mr. Buddy	Fishing	0/0	Taking on Water	Unknown[1]
Four Daughters	Fishing	0/0	Aground	Unknown
Lady Lee	Utility	0/0	Aground	Unknown
Pat Lytle	OSV[2]	0/0	Aground	Unknown
A. V. Conner	Liftboat	0/0	Adrift	Unknown
David McCall	Passenger	0/2	Aground	$85,000
Malcolm E	Fishing	0/0	Disabled	Unknown
Bam I	Jack-up Rig	0/0	Collision With Object	Unknown
Capt. Luke	Unknown	0/1	Unknown	Unknown
Daddy Dana and Tow	Towboat	Unknown	Unknown	$25,000
Aimee Danos	Lift Barge	0/0	Sunk	Unknown
Hope	Unknown	Unknown	Collision	Unknown
Thomas Jefferson	Ferry	0/0	Aground	Unknown
Kelpie	Fishing	0/0	Aground	$118,000
Main Pass 306 C	Platform	0/1	Unknown	Unknown
Cortez	Crewboat	0/0	Sunk	Unknown
McDermott 22	Barge	0/0	Adrift	Unknown
Lightning D	Crewboat	0/0	Adrift	Unknown
Tarheel 6	Utility	0/0	Damaged Windows	Unknown
Kelli Chouest	OSV	0/0	Aground	Unknown
Miss Germaine	Fishing	0/0	Sunk	$285,000
Gari Ellen	Crewboat	0/0	Adrift, Aground	Unknown
Skippin Sue	Crewboat	0/0	Adrift	$2,000
Jo Jack	Fishing	0/0	Aground	Unknown
Miss Shirley	Crewboat	0/0	Aground	$400,000
Robin Bordelon	Crewboat	0/1	Injury	Unknown
South Pass 60 C	Platform	0/2	Injuries	Unknown
Nicki Candies	OSV	0/0	Aground	Unknown
Wild Harvest	Fishing	0/0	Aground	Unknown
Master George	Fishing	0/0	Aground, Towed	$57,500
Miss Sheila	Crewboat	0/0	Sunk	Unknown
Gottman	Fishing	0/0	Sunk	Unknown
Gulf Seas	Towboat	0/0	Sunk	Unknown
Tech I	Liftboat	0/0	Sunk	Unknown
Bocha	Liberian Freighter	0/0	Dragged Anchor	Unknown
Car I	OSV	0/0	Aground	Unknown
Jake	OSV	0/0	Sunk	$5,000,000
Concrete Tow	Platform	0/0	Adrift	Unknown
A. M. Howard	Liftboat	3/0	Sunk	Unknown
Penrod 61	Drilling Rig	1/0	Capsized	Unknown
Penrod 60	Drilling Rig	0/0	Damaged	Unknown
Inca	Liftboat	0/0	Legs Damaged	Unknown
Sea Lift	Liftboat	0/0	Legs Capsized	Unknown
Venus	Utility Boat	0/0	Damaged	Unknown
Jerry C	Small Workboat	0/0	Damage	Unknown
Randolph Yost	Drilling Rig	0/0	Significant Damage	Unknown
Yorktown	Drilling Rig	0/0	Significant Damage	Unknown
J. Storm Rig II	Drilling Rig	0/0	Conductor Casing Listed 15°	Unknown

Table D-4. Reported Vessel Casualties in the Gulf of Mexico Attributable to Hurricanes (continued)

Name	Type	Death/ Injury	Result	Cost
Hurricane Juan (continued)				
Dixielyn Field 80	Drilling Rig	0/0	Listed	Unknown
Valient	Motor Vessel	Unknown	Hit by Barge	Unknown
Cynthia	Crew	0/1	Unknown	Unknown
Berwich	Tank Barge	0/0	Collision	$3,000
Brice Eserman	Towing	0/1	Collision	$38,000
Sybil I	Foreign Freighter	1/0	Aground	Unknown
Lady Dolphin	Utility Boat	0/0	Stern Sunk	$456,000
Miss Agness	OSV	1/0	Sunk	$1,250,000
Gilbert G	Stand-by Vessel	0/0	Missing	Unknown
Bill Bordelon	Tug	0/0	Damaged	$4,230
M/V Car I	OSV	0/0	Grounded	$200,000
Sea Horse Marine of Louisiana	Oil Barge	0/0	Collision	$8,000
Dixielyn Field 76	Drilling Rig	Unknown	Structural Damage	$500,000
Mr. Charlie	Submersible	Unknown	Structural Damage	Unknown
Sealift 4	Liftboat	Unknown	Sunk	Unknown
Gulf Island IV	Liftboat	Unknown	Structural Damage Adrift	Unknown
Power IV	Liftboat	Unknown	Aground	Unknown
Les Walters	Liftboat	Unknown	Structural Damage	Unknown
Elo	Liftboat	Unknown	Collision	Unknown
Miss Ruth	Liftboat	Unknown	Structural Damage	Unknown
Unnamed Fishing Vessel	Miscellaneous	Unknown	Sunk	Unknown
Gortman	Miscellaneous	Unknown	Sunk	Unknown
Rojo	Miscellaneous	Unknown	Unknown	Unknown
Ella Mae G.	Miscellaneous	Unknown	Aground	Unknown
Johnny G.	Miscellaneous	Unknown	Unknown	Unknown
Hurricane Elena				
Prober	Jack-up Rig	0/0	Spud Cans Damaged	$700,000
Zapata	Semi-Submersible	0/0	Unknown	$300,000
Yorktown	MODU[3]	Unknown	Unknown	Unknown
Hurricane Danny				
None Reported[1]				
Hurricane Kate				
None Reported[1]				

[1] Accident reports are required for accidents where there is a loss of life, personal incapacitation in excess of 72 hours, or an excess of $25,000 damage to property, etc. (46 CFR 4.05). It is believed some damages occurred to additional vessels, but not significant enough to warrant filing an accident report.

2 OSV - Offshore Supply Vessel

3 MODU - Mobil Offshore Drilling Unit

Source: U.S. Coast Guard, 1986.

e. Highways

Estimated costs for highway repair and related damages by the Louisiana Department of Transportation and Development for Hurricanes Danny and Elena were $453,640 and for Hurricane Juan, $3,148,286 (Creagon, 1985). Road/road-related repair costs in coastal Alabama for Hurricane Elena were $561,000 for Baldwin Country and $156,500 for Mobile County (Poiroux, 1986).

f. Agriculture

Hurricane Juan resulted in a $194,663,585 agricultural economic loss in Louisiana. This included $174,934,146 for crops, $11,951,664 for soybean quality loss, $5,686,500 for total immovables (farm buildings, mobile homes, service buildings, equipment, and land damage), $450,250 for livestock, and $1,641,025 for aquaculture (Byrd, 1986). The sugarcane and soybean crops sustained the most damage. Other major crops, such as cotton, rice, and sweet potatoes, had already been harvested prior to the hurricane.

g. Other Economic Impacts

The 1985 hurricanes resulted in impacts on schools, public offices, and other facilities/operations in Louisiana. Included were cost estimates of $51,896 for Belle Chase State Schools, $38,088 for Washington Parish Sheriff's Offices, $75,927 for the city of Bogalusa, $15,208 for the town of Franklinton, $292,136 for the military, $127,355 for the Department of Public Safety and Corrections, $124,262 for the Department of Public Safety and Corrections Office of Emergency Preparedness, and $124,635 for the Golden Meadow Vocational Technical School (Creagon, 1985). The American Red Cross (1986) reported that it provided $8,000,000 in assistance to families in south Louisiana as a result of Hurricane Juan and $400,000 as a result of Hurricane Danny.

Hurricane Danny forced a major evacuation of the Mississippi coast. It cost property owners in Mississippi an estimated $51,000 in damages. Hurricane Elena was particularly devastating to the area with damage estimates of more than $500,000,000. Approximately $500,000 to $700,000 in damages, due to flooding, were the results of Hurricane Juan (The Sun Herald, 1986b).

Total cost estimates reported for 1985 hurricane damages to the coastal counties of Alabama were: $336,969 for State agencies; $1,041,620 for Baldwin County, and $1,722,806 for Mobile County. These were estimates for eligible applicants under the Public Assistance Program (Bennett, 1986).

B. EASTERN GULF

1. Environmental Losses

a. Shorelines

Hurricane Elena affected the beaches and shores of the Florida west coast from Escambia County through Sarasota County, a shoreline distance of about 494 statute miles. Balsillie (1985) performed a Type I erosion value analysis relative to Hurricane Elena's affects on Florida's beaches and shores. This was an average for sampled profiles where only erosion occurred. Through this analysis, it was determined that beach and coast erosion volumes from Pinellas, Franklin, Gulf, and Escambia Counties ranged from 8.3 to 15.6 cubic yards per shorefront foot of coast. The average erosion was 10 cubic yards per foot.

b. Wildlife and Fisheries

Holloman (1986) provided information on estimated wildlife damages at the St. Vincent NWR. The 1985 hurricanes resulted in the death of five deer, two loggerhead sea turtle nests were destroyed, and both eagle nests on the island were destroyed. A dolphin was temporarily stranded on the beach and there were massive fish kills in the freshwater lakes on the island. In addition, many trees and understory vegetation were destroyed or damaged. At the

St. Marks NWR, seven eagle nests were destroyed in an impoundment and some trees were destroyed or damaged (White, 1986).

Shellfish resources in Apalachicola Bay, Franklin County, sustained severe damage. This bay system is vital to the oyster industry of Florida with over 90% of Florida's oyster landings coming from this bay. In 1984, approximately 900 oyster harvesting licenses were issued in Franklin County. Many oystermen harvest off neighboring counties of this bay. The reefs were impacted by extreme tidal activity, hurricane force winds, and heavy rainfall from Hurricane Elena. Oyster populations were subjected to acute mechanical and physiological stress which may have drastically altered oyster population dynamics on impacted reefs. Damage assessment following the storm indicate oyster populations on the bay's most productive reefs (Cat Point Bar and East Hole Bar) had been reduced to levels which would not support commercial harvesting. Commercially harvestable concentrations of oysters on Cat Point Bar were reduced to approximately 20% of the estimated harvestable oysters present before the storm. Those resources on East Hole Bar were virtually eliminated (Berrigan, 1986).

2. Economic Losses

a. Beaches and Shores

Basillie (1985) conducted Type II volumetric erosion values relative to Hurricane Elena. These values included all profiles regardless of gain or loss of beach/coast. From these values, it was suggested that the lower gulf and panhandle coasts of Florida resulted in $12,400,000 to $22,900,000 of beach and coast erosion damage.

b. Seafood Industry

As a result of the damage to the Apalachicola oyster reefs from Hurricane Elena, $1,570,000 was requested for emergency funding under Chapter 4B of the Marine Fisheries Research and Development Act (PL 88-309) to reconstruct natural oyster reefs (Simpson, 1986). Estimated losses in potential oyster production in Apalachicola Bay's Cat Point Bar and East Hole Bar exceeded $30,000,000. Estimated losses in potential dockside revenues from harvests exceeded $6,000,000 (Berrigan, 1986).

c. Wildlife Facilities and Parks

Hurricane Elena resulted in replacement/repair cost estimates of $128,500 for the St. Vincent NWR. Included were estimates for such items as the mainland docks/pier and floating docks, boat house, storage barn, cabin screens, and dredging (Holloman, 1986). At the St. Marks NWR, cost estimates to repair/replace items damaged by Hurricane Elena were estimated to be $49,000. Included were estimates for erosion damages to dikes on managed impoundments, 18 miles of Executive Order boundary that washed away, and 60 miles of coastal marsh and river boundary signs that washed away. Hurricane Kate resulted in $40,000 worth of damage to the refuge (White, 1986). Cost estimates for damages to the Gulf Islands National Seashore in Gulf Breeze, Florida, were in excess of $72,000. The cost breakdown included $42,500 to repair the Fort Pikens Road, $5,000 to repair boardwalks, $20,000 to repair the Perdido Key Road, and $5,000 to repair the Santa Rosa Area road (Woodside, 1986). Table D-5 shows uninsured damages on Florida's State Parks as a result of Hurricane Elena. Table D-6 shows Hurricane Elena damages that were expected to be covered by insurance on Florida's State Parks.

d. Highway

Hurricanes Elena and Kate caused tremendous damages to the highway systems in Franklin, Gulf, and Bay Counties, Florida. U.S. Highway 98 damage estimates were $750,000 for Hurricane Elena and $1,500,000 to $2,250,000 for Hurricane Kate. The 1985 hurricanes resulted in $2,500,000 to $3,000,000 in damages to the St. George Island Causeway. Miscellaneous highway damages in Gulf County amounted to $50,000 (Spangenberg, 1986).

Table D-5

Uninsured Damages to Florida's State Parks as a Result of Hurricane Elena

County	State Park	Amount
Alachua	Devil's Millhopper	$250
Citrus	Crystal River	$200
Collier	Delnor-Wiggins Pass	$1,000
Escambia	Big Lagoon	$3,300
Franklin	Cape St. George	$600
Franklin	St. George Island	$504,664
Gulf	St. Joseph Peninsula	$2,500
Lee	Cayo Costa	$8,000
Lee	Koreshan	$250
Lee	Lover's Key	$200
Leon	Natural Bridge	$1,000
Levy	Manatee Springs	$750
Monroe	Ft. Zachary Taylor	$1,500
Orange	Tosohatchee	$1,000
Pinellas	Caladesi Island	$800
Pinellas	Honeymoon Island	$147,000
Sarasota	Oscar S.	$150
Wakulla	Ochlockonee	$23,000
Wakulla	San Marcos de Apalachee	$1,500
Walton	Grayton Beach	$5,000
Grand Total		$702,664

Source: Barber, 1986.

Table D-6

Insured Damages to Florida's State Parks as a Result of Hurricane Elena

County	State Park	Amount
Columbia	Ichetucknee Springs	$200
Escambia	Big Lagoon	$56
Escambia	Perdido Key	$500
Franklin	St. George Island	$2,300
Franklin	Cape St. George	$700
Gulf	St. Joseph Peninsula	$7,100
Lee	Cayo Costa	$1,000
Liberty	Torrega	$500
Pinellas	Honeymoon Island	$33,550
Pinnelas	Weedon Island	$5,478
Walton	Eden	$300
Wakulla	San Marcos de Apalachee	$1,000
Grand Total		$52,684

Source: Barber, 1986.

VI. SUMMARY

The 1985 Gulf of Mexico hurricanes were both environmentally and economically devastating. In the Central and Eastern Gulf of Mexico areas, coastal erosion and land loss were tremendous. Wildlife losses were fairly heavy in the Central Gulf area but appeared to be less in the Eastern Gulf area. Oyster resources were heavily impacted in the Central Gulf area (Mobile Bay) as well as in the Eastern Gulf area (Apalachicola Bay). The oil and gas industries suffered millions of dollars in losses in the Central Gulf. Wildlife facilities and parks suffered heavy economic losses in both areas. Likewise, highway damages in both areas were in the millions of dollars. Agricultural damages as well as damages to homes, schools, and other facilities were heavy in the Central Gulf area; however, at the time of this writing, no estimate of those damages in the Eastern Gulf area were available.

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Appendix E

Investigation of Wetlands Loss in Louisiana Coastal Region: A Pilot Study

INTRODUCTION

In conjunction with MMS Study G-538 entitled "Outer Continental Shelf Development and Potential Habitat Alteration" and as a result of much attention being focused on man-induced impacts from canalization related to oil and gas support activities, both off- and onshore, a pilot study was initiated by the Environmental Assessment Section of the Gulf of Mexico OCS Region to examine the primary (physical) and secondary impacts of these activities within the Louisiana coastal zone. This pilot study was conducted not only to look at the causative factors, both natural and man-induced, but also to familiarize the MMS environmental staff with the complexity of quantitatively evaluating the role that the Federal OCS oil and gas program has had as a contributor to wetlands loss in Louisiana in relation to other causative factors.

DESCRIPTION OF THE LOUISIANA WETLANDS COMPLEX

Throughout the Holocene, sediment laden waters have fanned out along the southern Louisiana coastline, creating two distinct zones: the Deltaic and Chenier Plains. The Deltaic Plain is the site of a series of seven deltaic lobes which extended seaward at different times during the last 6,000 to 7,000 years. Except for the seaward part of the modern "bird's foot" delta, each lobe advanced into the shallow waters of the continental shelf and was characterized by numerous distributaries. These channels continued to bifurcate, thus aiding the distribution of the river sediments and progradation of the coast. Through time, the recurring channel changes created the intricate "horsetail" pattern of levee fingers extending into the wetlands. Much of this land is comprised of alluvial ridges, beaches, marsh, and surface water, where accretion has been replaced by subsidence and erosion. On southwestern Louisiana's near-sea-level grasslands, the surface is broken by a series of long, narrow sand ridges, called cheniers. The cheniers were formed by wave action pushing sand up onto shore. Each chenier marks the position of a once active shoreline. When the Mississippi River occupied one of its western courses, clays, muds, and sands were carried westward by littoral currents advancing the Chenier Plain. Interruptions in the progradation process allowed coarser particles to accumulate as a ridge. An increase in sedimentation caused the shoreline to advance, leaving the conspicuous, oak covered chenier as the region's most impressive and continuous topographic feature (Davis, 1982).

Within both the Chenier and Deltaic Plains lie 40% of the Nation's marsh ecosystems, which encompass an area of approximately 4.2 million acres (1.7 million hectares) and span the full coastline of the state. They extend inland for distances ranging from 15-50 miles (24-80 km) and reach their greatest width in southeastern portion of the State. These areas provide a habitat for more than two-thirds of the Mississippi flyway's wintering waterfowl, the largest fur and alligator harvests in North America, and more than 25% of the nation's commercial fisheries, or an annual catch of more than 1.5 billion pounds of estuarine-dependent fish and shellfish.

Water levels in these marshes are greatly affected by rainfall, tides, and local drainage patterns. Tidal effects are greater in areas near the Gulf of Mexico shoreline; however, tide levels also affect drainage from the interior marshes. Aside from its affect on marsh water levels, this tidal action provides a source of highly saline water to the marshes. Daily tidal fluctuations cause the highly saline waters to move inland and mix with the advancing fresh water to form a vast estuarine basin. Water salinities range from highly saline near the coastline, with a gradual decline inland, to a zone of freshwater near the northern perimeter of the marsh region (Chabreck, 1982).

The coastal marshes are subdivided into four vegetative types: saline, brackish, intermediate, and fresh. The types occur in bands generally paralleling the coastline and contain characteristic water salinity levels and plant communities. The saline marshes border the shoreline of the Gulf and are subject to daily tidal fluctuations. This marsh type forms a narrow band in the chenier plain, but is very extensive in the Deltaic Plain. The two regions combine to form a total salt marsh area of 667,184 acres (270,000 hectares). The saline marsh of the deltaic plain is dissected by numerous embayments and tidal inlets and as a result is exposed to rapid and drastic tidal action. The shoreline of the Chenier Plain is fringed by an almost continuous beach deposit which restricts the intrusion of Gulf waters and delays freshwater runoff. The brackish marsh is further removed from the influence of highly saline Gulf waters; however, it is still subject to daily tidal action. The brackish marsh is a major vegetative type of coastal Louisiana and comprises 1.28 million acres (520,000 hectares). Normal water depths exceed that of saline marsh and soils contain higher organic content. Brackish marsh contains a greater plant diversity then the saline marsh, and characteristically contains numerous bayous and lakes. The intermediate marsh lies inland from the brackish marsh and occupies an area of 691,894 acres (280,000 hectares). This area receives some influence from tides. Plant species diversities are high and the area contains both halophytes and freshwater species used as food by a wide variety of herbivores. The fresh marsh (Figure E-1) occupies the zone inland from the intermediate marsh and south of the prairie formation and Mississippi alluvial plain. In many areas fresh marsh is intermixed with forested wetlands or swamp. This area encompasses an area of 1.3 million acres (530,000 hectares). Due to slow drainage within this area, water depth and soil organic content are greatest. In some areas where soil organic matter content exceeds 80%, the substitute for plant growth is floating organic matter referred to as flotant. This marsh type supports the greatest diversity of plants and contains many species which are preferred foods of wildlife (Chabreck, 1982).

THE WETLANDS LOSS ISSUE

With the exception of the active Mississippi and Atchafalaya River Delta fronts, and as a result of man-induced impacts and the natural processes of erosion and sea level rise/subsidence, the wetlands within the Deltaic Plain alone are disappearing at a net rate estimated at 100 km^2 per year or approximately 40 mi^2 (Gosselink, 1985). Figure E-2 illustrates this loss between the years 1956 and 1978. Although wetland degradation is a natural part of the 5,000 year cycle of growth and decay of a Mississippi River delta lobe; this rate of loss has been accelerated by man's impact to the coastal wetlands. The activities of man, which include leveeing, canal dredging, stream channelization, land drainage and landfills, have reduced the effectiveness of natural saltwater barriers and altered hydrological processes.

Since the late 1930's, rapid economic growth and development has occurred in Louisiana's wetlands. Much of this growth includes agricultural and urban land conversion, as well as hydrocarbon extraction from onshore, and more recently, offshore development. The growth of oil and gas exploration during the past three decades has placed a demand on the coastal zone to furnish support for both the offshore and onshore oil and gas industries. The need for land for support bases, platform fabrication yards, pipeyards, shipyards, etc. has greatly increased. Aside from these needs, there existed a need to get men and equipment to the resources and to transport the resource once discovered. As a result, a vast network of canals and pipelines was constructed across the entire Louisiana wetland complex. Most of these canals were, and are used, for all types of navigation purposes, including the transport of men and equipment to and from off- and onshore complexes. However, a number of these canals are a result of man's failure to backfill pipeline canals and exploration drilling canals upon completion of such projects.

Canals have increased in area from practically zero at the beginning of the century to about 2.4% of the Louisiana coastal surface area in 1978. Although they are conspicuous features of the south Louisiana wetlands, at surface level, their great length, density and diversity could go unnoticed. However, when viewed from an aircraft, they stand out as dominant geomorphic features. Almost all were constructed to help in recovery of mineral deposits and they abound in every parish, in every wetland plant community and soil type, and have increased gradually in density. (Turner et al., 1982). These canal networks contribute significantly to wetlands loss in the Louisiana coastal region, both directly and indirectly. The direct effects are the immediate conversion of wetlands to canals and spoil banks during construction, and subsequent widening of canals as their banks erode through time. Indirect effects are marsh deterioration from saltwater intrusion and changes in hydrologic patterns that result when deep, straight canals are dredged through the wetlands. Canals and channelized streams which connect tidal saltwater sources to inland marshes of lower salinity can function in two ways to alter vegetative types. During low tides, the canals flush freshwater from interior marshes and lower water levels and then, with the high tides, saltwater from the Gulf is able to move farther inland. As water salinity increases within an area, fresher intermediate marsh plants unable to tolerate the higher salinity die (Figure E-3) and are gradually replaced by species adapted to the new salinity regimes. The greatest damage to plants takes place when the fresh marsh, which contains higher levels of soil organics, is subjected to water of much greater salinity and strong tidal actions. Plants within the area are killed due to the increased salinities and the organic substrate becomes dislodged without plant roots to hold it together. As the tide moves in and through the area, small amounts of organic matter are picked up by the current and flushed out through tidal channels. Before new species can become established, marsh elevations may drop 10 to 20 cm over vast areas with open bays and lakes developing and productive marsh being lost (Chabreck, 1982).

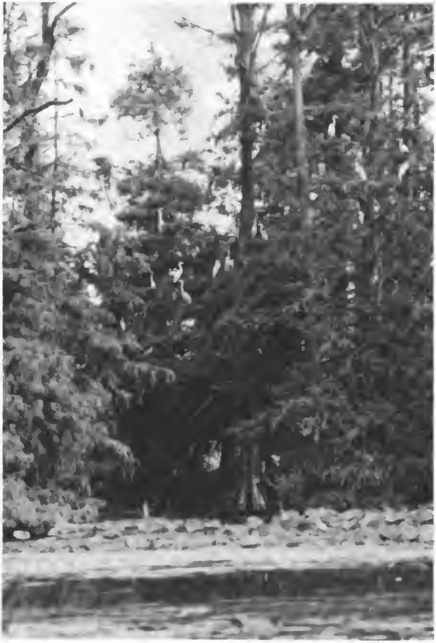


Figure E-1. Natural fresh marsh and bird rookery in south Louisiana.

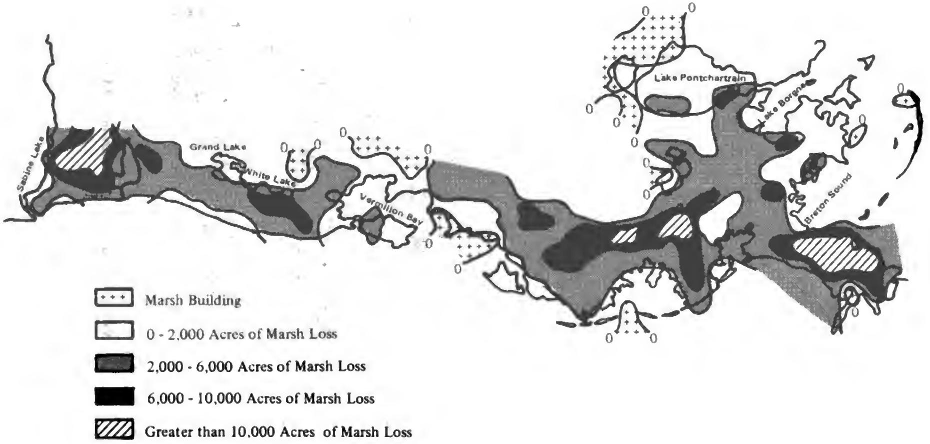


Figure E-2. Wetlands Profile - Between the Years 1956 - 1978 (Louisiana)

Sabine Lake
Grand Lake
White Lake
Vermilion Bay
Lake Pontchartrain
Lake Borgne
Breton Sound
0
+ + + Marsh Building
0 - 2,000 Acres of Marsh Loss
2,000 - 6,000 Acres of Marsh Loss
6,000 - 10,000 Acres of Marsh Loss
Greater than 10,000 Acres of Marsh Loss

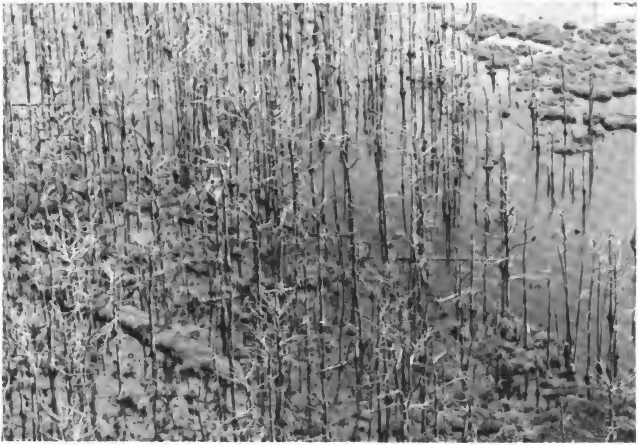


Figure E-3. Illustrates effects of saltwater intrusion on bald cypress stand.

METHODOLOGY

The study was broken into three components which consisted of a pipeline mapping project and a computer/graphics project, both developed in-house, and a four-day aerial reconnaissance field effort in the coastal marsh areas of Louisiana.

The pipeline mapping project consisted of mapping all Federal OCS pipelines that extend across State waters and made landfall into the Louisiana wetlands on eight base maps with a scale of 1:250,000. The pipelines were then traced from landfall across the wetlands to the most northern portion of the marsh or to the first tie-in. Pipelines were labeled by size, product, and company designation. Over two-thirds of the major companies having pipelines with Louisiana landfalls were contacted and maps or drawings were requested. Approximately one-half of these responded with maps and/or as-built drawings.

The computer project consisted of taking the 1956 and 1978 U.S. Fish and Wildlife habitat data and calculating the percent of wetlands loss within each of six sample areas over the 22-year representative time frame. Sample sites were selected with the following guidelines or parameters:

(1) 241 quadrants (7.5 minute) of available habitat data across both the Chenier and Deltaic Plains, were ranked by percentage of annual wetlands loss (Figure E-4). Those quadrants receiving the lower rankings (1-160) had the least amount of loss by area, while those receiving the higher rankings (161-241) had the greatest amount of loss.

(2) Table E-1 was compiled and depicts wetlands loss by hydrologic units, for both the Chenier and Deltaic Plains. These areas were categorized by percent of marsh loss per unit, then grouped in the following manner (Figure E-4):

High = Greater than 50% loss
Medium = 15-50% loss
Low = 0-15% loss

(3) Following steps (1) and (2), two 7.5 minute quadrants were chosen for each of the areas and assigned a high, medium, or low designation. One quadrant represents the higher ranking or area of greatest loss, while the other represented the lower ranking or area of least loss. The quadrants chosen are as follows:

High - High: Pass A. Loutre, West (212)
Low: Dixon Bay (4)

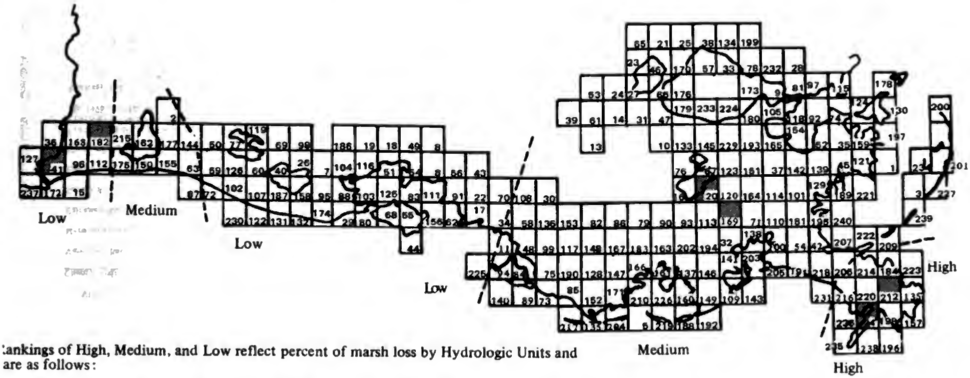
Medium -High: Three Bayou Bay (169)
Low: Barataria (20)

Low - High: Five Lakes (182)
Low: West of Johnson's Bayou (41)

For sample site selection, it was deemed necessary to reduce the sample area size to one-quarter of each quadrant's original area 40,000 acres (16,187 hectares) to expedite the field reconnaissance work. Therefore, for those areas with the higher rankings, or greatest loss per area, which include Pass A Loutre, West; Three Bayou Bay; and Five Lakes, the most perturbated quarter of each quadrant was chosen. For the areas with the lower rankings, or least loss per area, which includes Dixon Bay; Barataria; and West of Johnson's Bayou, the least perturbated quarter of the quadrant, was selected. Once this was accomplished the sample sites were as follows:

(High) Site 2: High - Pass A Loutre, West; NW 1/4; 9,893 acres (4,004 ha)
Site 1: Low - Dixon Bay; NW 1/4; 10,959 acres (4,435 ha)

Figure E-4. Louisiana Wetlands Quadrant Ranking (Annual Percent Loss)



:ankings of High, Medium, and Low reflect percent of marsh loss by Hydrologic Units and are as follows:

ligh - Mississippi Deltaic Plain (MDP), Hydrologic Unit III, Greater than 50%
ledium - MDP, Hydrologic Units II, IV, andV
Chenier Plain, Calcasieu Basin Unit,
From 15 to 50%
.ow - MDP, Hydrologic Units VI andVII
Chenier Plain, Sabine Basin Unit
, Chenier Basin Unit
, Mermentau Basin Unit
, Vermilion Basin Unit
From 0 to 15%

Table E-1

Louisiana Coastal Land Loss Comparison Chart

	Total Marsh (Acres)[1]	Marsh Change (Acres)[2]	Rate per Year (Acres)[2]	Percent of Marsh Lost[2]	Percent Change in Canals[2]	Acres Canal Acres Marsh[3]	Percent Change in Spoil[2]	Acres Spoil Acres Marsh[1]
Mississippi Deltaic Plain								
I	66,818	-5,891	-267	-8.1	+276	.015	+381	.035
II	468,804	-79,223	-3,601	-14.5	+107	.039	+331	.050
III	66,153	-67,883	-3,086	-51	-1.6	.047	+303	.130
IV	405,645	-126,961	-5,771	-24	+85	.048	+199	.055
V	541,669	-155,457	-7,066	-22	+168	.031	+194	.028
VI	58,922	-5,772	-262	-9	+105	.071	+91	.085
VII	248,669	-17,541	-797	-6.6	+105	.040	+123	.025
Chenier Plain								
Vermilion Basin	108,663	-10,194	-463	-8.5	-	-	+222	.01
Mermentau Basin	317,274	-23,131	-1,051	-6.8	-	-	+13	.003
Calcasieu Basin	159,448	-37,224	-1,715	-19.1	-	-	+34	.006
Sabine Basin	352,158	-27,274	-1,240	-7.2	-	-	+11	.008
East Bay	60,013	-1,250	-57	-2.0	-	-	+2	.0034
Chenier Ridge	190,378	-7,042	-320	-3.6	-	-	+73	.008

[1] 1978 for Mississippi Deltaic Plain, 1974 for Chenier Plain.
[2] 1956-1978 for Mississippi Deltaic Plain, 1952-1974 for Chenier Plain
[3] In 1978 for Mississippi Deltaic Plain.

Sources: U.S. DOI/FWS-MMS 1983. Ecological Characterization of the Mississippi Deltaic Plain Region, FWS/OBS-82/69; 189 pages.
U.S. DOI/FWS, 1979. An Ecological Characterization Study of the Chenier Plain Coastal Ecosystem of Louisiana and Texas. Volume 1, FWS/OBS-78/9, 302 pages.

(Medium) Site 4: High - Three Bayou Bay; NE 1/4; 11,112 acre (4,497 ha)s
Site 3: Low - Barataria; SW 1/4; 11,080 acres (4,484 ha)

(Low) Site 5: High - Five Lakes; SE 1/4; 10,731 acres (4,343 ha)
Site 6: Low - West of Johnson's Bayou, SW 1/4; *

(*Data was unavailable for computer overlay comparison work)

Following site selections, both the 1956 and 1978 wetlands data for each site were calculated and graphically depicted. (Use Table E-2 to key habitat types for data in Tables E-3 through E-7.)

Following the collection of sample site data and data analyses, on a four-day aerial reconnaissance of the sample areas was conducted, with three objectives in mind:

(1) to photo-document wetlands sites of south Louisiana as they existed in 1985;

(2) to make an ocular estimate of the extent of wetlands loss after, and with respect to, the 1978 data; and

(3) to furnish a perspective of the vast Louisiana wetlands and the complexity of such a system as it relates to man-induced and natural processes.

Both video (VHS) and 35 mm cameras were used to document this trip. The trip itinerary consisted of three legs, as shown in Figure E-5.

SUMMARY AND OBSERVATIONS

As was discussed previously, this pilot project was an attempt to briefly examine wetlands loss within the Louisiana coastal region. Due to the nature of this project, no attempt was made to arrive at any conclusions. However, as a result of the comparison and reconnaissance work undertaken, some general observations may be made about Louisiana's wetland complex and the issue of wetlands loss.

(1) The Louisiana wetlands are a very fragile and complex system, comprised of numerous and varied subsystems.

(2) Throughout this system, we failed to see any areas void of man's influence (direct or indirect).

(3) Although natural causative factors play a substantial role in the wetlands loss issue, it became very apparent that man's role may be as great, if not greater, in contributing to this problem.

(4) In terms of the rate and completeness of wetlands recovery following construction activities, there is a very distinct difference between the Chenier and Deltaic Plains regions.

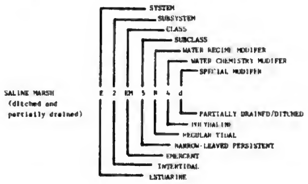
(5) Across the State, secondary impacts (saltwater intrusion, etc.) appear to be more substantial than primary (physical) impacts within the Louisiana coastal region.

(6) If the current rate of wetlands development and erosion is not reduced, and existing or improved technology is not utilized to restore those areas which can be returned to productive wetlands, a large portion of these areas will be lost in the next 50 years, as shown in Figure E-6.

Explanation of Habitat Map Symbols

HABITAT TYPE

HABITAT LABELING SYSTEM



HABITAT MAP SYMBOLS

SYSTEM AND SUBSYSTEM

*SYSTEM
 *subsystem

- M MARINE
  - 1 subtidal
  - 2 intertidal
- E ESTUARINE
  - 1 subtidal
  - 2 intertidal
- P PALUSTRINE
  - - no subsystem
- R RIVERINE
  - 1 tidal
  - 2 lower perennial
  - 3 upper perennial
  - 4 intermittent
- L LACUSTRINE
  - 1 limnetic
  - 2 littoral
- U UPLAND
  - - no subsystem

CLASS AND SUBCLASS

*CLASS
 *subclass

- AB AQUATIC BED
  - 1 submergent algal
  - 2 submergent vascular
  - 3 submergent moss
  - 4 floating-leaved
  - 5 floating
  - 6 unknown submergent
  - 7 unknown surface
- BB BEACH/BAR
  - 1 cobble/gravel
  - 2 sand/shell
- EM EMERGENT
  - 1 persistent
  - 2 nonpersistent
  - 3 narrow-leaved nonpersistent
  - 4 broad-leaved nonpersistent
  - 5 narrow-leaved persistent
  - 6 broad-leaved persistent
- FL FLAT
  - 1 cobble/gravel
  - 2 sand/shell
  - 3 mud
  - 4 organic
  - 5 vegetated pioneer
  - 6 vegetated non-pioneer
- FO FORESTED
  - 1 broad-leaved deciduous
  - 2 needle-leaved deciduous
  - 3 broad-leaved evergreen
  - 4 needle-leaved evergreen
  - 5 dead
  - 6 deciduous
  - 7 evergreen
- OW OPEN WATER
  - unknown bottom
- RF REEF
  - 1 coral
  - 2 mollusc
  - 3 worm
- RS ROCKY SHORE
  - 1 bedrock
  - 2 boulder
  - 3 vegetated non-pioneer
- SB STREAM BED
  - 1 cobble/gravel
  - 2 sand
  - 3 mud
  - 4 organic
- SS SCRUB/SHRUB
  - 1 broad-leaved deciduous
  - 2 needle-leaved deciduous
  - 3 broad-leaved evergreen
  - 4 needle-leaved evergreen
  - 5 dead
  - 6 deciduous
  - 7 evergreen
- UB UNCONSOLIDATED BOTTOM
  - 1 cobble/gravel
  - 2 sand
  - 3 mud
  - 4 organic
- DV DEVELOPED
  - 1 urban/residential/commercial/industrial
  - 2 agriculture/pasture/modified grasslands
  - 3 unvegetated land/spoil/disposal sites
- GR GRASSLANDS

WATER REGIME MODIFERS

NONTIDAL

- A temporary
- B saturated
- C seasonal
- D seasonal/well-drained
- E seasonal/saturated
- F semipermanent
- G intermittently exposed
- H permanent
- J intermittently flooded

TIDAL

- L subtidal
- M irregularly exposed
- N regular
- P irregular
- R seasonal
- S temporary
- T semipermanent
- V permanent

NONTIDAL COMBINED

- Z intermittently exposed/permanent (G, H above)
- W intermittently flooded/temporary (J, A above)
- Y saturated semipermanent/all seasonals (B, C, D, E, F, above)

NONTIDAL & TIDAL

- U unknown
- K artificial

WATER CHEMISTRY MODIFERS

COASTAL HALINITY MODIFER

- 1 hyperhaline
- 2 euhaline
- 3 mixohaline (brackish)
- 4 polyhaline
- 5 mesohaline
- 6 oligohaline
- - fresh

INLAND SALINITY MODIFER

- 7 hypersaline
- 8 eusaline
- 9 mixosaline
- - fresh

pH FRESH WATER MODIFER

- a acid
- t circumneutral
- i alkaline

OTHER MODIFERS

SPECIAL MODIFERS

- b beaver
- d partially drained/ditched
- e reclaimed wetland
- f farmed
- h diked/impounded
- r artificial
- s spoil
- x excavated
- o oil/gas/mineral
- t tidal
- p beach

SOIL MODIFERS

- g organic
- n mineral

Table E-2. Key to Habitat Labeling System (U.S. Fish and Wildlife Service).

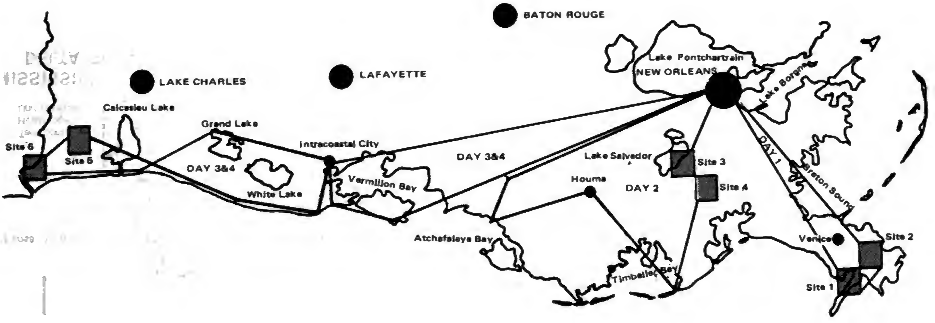


Figure E-5. Field Trip Itinerary.

Day 1 (Mississippi Deltaic Plain)
Site 1 - Dixon Bay Quadrant
Site 2 - Pass A Loutre West Quadrant

other areas: Venice Oil Field, Venice, Port Eads (South Pass)

Day 2 (Barataria Basin)
Site 3 - Barataria Quadrant
Site 4 - Three Bayou Bay Quadrant

other areas: East Timbalier Island, Houma, Atchafalaya Delta

Day 3 and 4 (Chenier Plain)
Site 5 - Five Lakes Quadrant
Site 6 - West of Johnson's Bayou Quadrant

other areas: Marsh Island, Intracoastal City, Rockefeller Wildlife Refuge, Sabine Wildlife Refuge, Cameron, Lacassine Wildlife Refuge

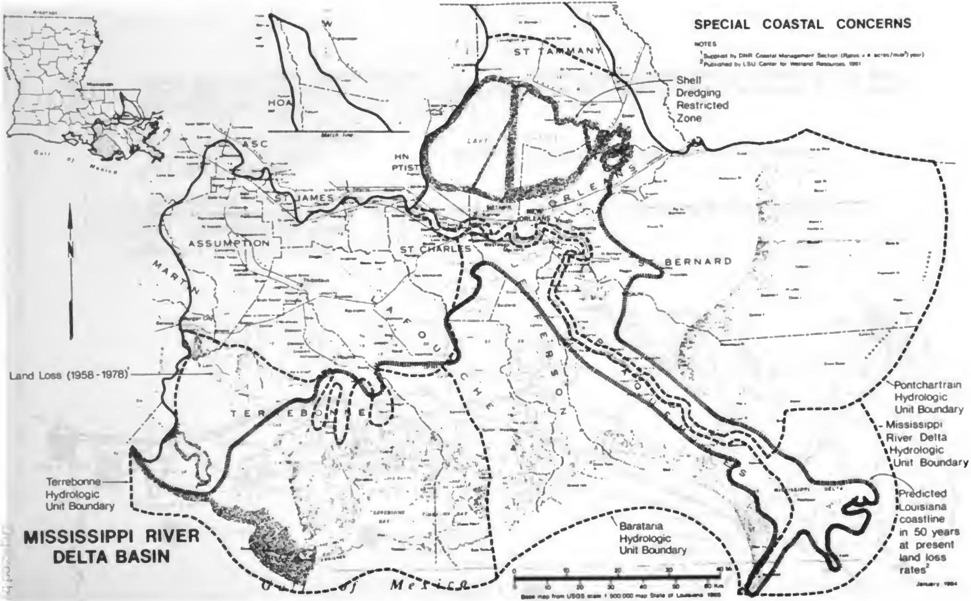

SPECIAL COASTAL CONCERNS
NOTES
1 Supplied by DNR Coastal Management Section (Rates = 4 acres/mile²/year)
2 Published by LSU Center for Wetland Resources, 1981
Shell Dredging Restricted Zone
ST TAMMANY
HOA
W
ASC
HN PTIST
ST JAMES
ASSUMPTION
ST CHARLES
ORLEANS
ST BERNARD
MARTIN
LAFOURCHE
JEFFERSON
PLAQUEMINES
TERREBONNE
N
Land Loss (1958-1978)¹
Pontchartrain Hydrologic Unit Boundary
Mississippi River Delta Hydrologic Unit Boundary
Predicted Louisiana coastline in 50 years at present land loss rates²
Terrebonne Hydrologic Unit Boundary
Barataria Hydrologic Unit Boundary
MISSISSIPPI RIVER DELTA BASIN
Gulf of Mexico
0 10 20 30 40 Mi
0 10 20 30 40 50 60 Km
January 1984

Figure E-6. Louisiana coastline in 50 years at present land loss rates². Taken from 1984 Report entitled "The Louisiana Water Resources Study" Louisiana Department of Transportation.

(7) The technology currently exists to begin restoration of many of these areas.

Despite the prospect of gloom and doom, there have been efforts taken to preserve many areas of the wetlands and slow down the current rates of erosion. Projects consisting of freshwater diversion, freshwater impoundments, marsh creation and revegetation, etc. have proven successful in many wetland areas throughout the State. Tighter restrictions on wetland development, utilization of new construction techniques, mitigation banking, and requiring construction site restoration work have also met with favorable results.

The State and Federal Governments have also stepped up their examination of this problem and taken action toward its alleviation. The State of Louisiana has recently implemented a 10-year master plan aimed at restoring and preventing shoreline and barrier island erosion across the State. A portion of the monies allocated for this multi-million dollar project will be used for restoring a portion of the interior wetlands, as well. The U.S. Corps of Engineers is currently engaged in several projects aimed at rebuilding the marsh and slowing-down saltwater intrusion into the coastal areas. Finally, the U.S. Dept. of the Interior's, Minerals Management Service is currently funding a $1.2 million study (G-538) entitled "Outer Continental Shelf Development and Potential Habitat Alteration." This study is being performed by the Center for Wetlands Resources at Louisiana State University. From this study, we hope to better understand the extremely complex nature of the problem.

REFERENCES

Chabreck, R.H. 1982. The Effect of Coastal Alteration on Marsh Plants. Proceedings of the Conference on Coastal Erosion and Wetlands Modification in Louisiana. U.S. Fish and Wildlife Service, pp. 92-98.

Davis, D.W. 1982. Economic and Cultural Consequences of land loss in Louisiana. Proceedings of the Conference on Coastal Erosion and Wetlands Modification in Louisiana. U.S. Fish and Wildlife Service, pp. 140-158.

Gosselink, J.G. 1985. Impacts of Pipeline Installations in Coastal Louisiana. Proceedings of Fifth Annual Gulf of Mexico Information Transfer Meeting. DOI/Minerals Management Service (MMS 85-0008), pp. 95-96.

Turner, R.E., Costanza, R., and Scaife W. 1982. Canals and Wetlands Erosion Rates in Coastal Louisiana. Proceedings of the Conference on Coastal Erosion and Wetlands Modification in Louisiana. U.S. Fish and Wildlife Service, pp. 73-84.

Site l-Dixon Bay NW 1/4:

Table E-3 represents the wetlands data for the years 1956, 1978 and 1983. These data and Figures E-7 and E-8 illustrate that between 1956 and 1978, there was a 21.4% increase in open water areas within the sample area; however between 1978 and 1983 these open water areas increased by less than 1%. Of the original 2,876.65 acres (1,164.14 hectares) of marsh and upland within this area in 1956, some 2,374.24 acres (960.8 hectares) were lost to open water between these years.

In 1956, the area was approximately 74% open water; however, in 1978 that percentage increased to almost 96%. The site illustrates the complexity of the land loss process occurring within the Louisiana coastal region. The interrelationship of both natural and man-induced impacts resulted in the loss of almost all of the marsh within the site area. As a result of leveeing and damming activities in the Mississippi watershed and along the Mississippi River, the sediment load to the area has been greatly depleted, and that sediment which makes its way down the river, primarily the finer particles, is washed out of the passes and into the Gulf's deeper waters. Aside from sediment depletion within this area over many decades, the modern delta has been rapidly experiencing subsidence resulting from an overburden of the thick sediment sequence below the delta and a resultant compaction and downwarping of the sequence. This has been well documented for many years. The area is highly vulnerable to erosional processes, stemming from wind and wave action which are further exacerbated by significant long-term sea level rise. The combination of these physical processes must be carefully inspected with an accounting of impacts due to changing salinity regimes within the area in assignment of wetlands loss to this area. As is shown in Figure E-9, most of the wetlands within the sample area have been lost to open water, with the remaining marsh fragments existing near leveeing activities which are a result of state oil and gas activities.

Area Summary for Map of Dixon Bay 1956, NW¼

SUBJECT		AREA	FREQUENCY	PERCENT
E1OW.	WETLOSS	7737.95	18	70.61
E1OWO.	WETLOSS	62.90	11	.57
PEM.	WETLOSS	2861.41	64	26.11
PFO1.	WETLOSS	12.77	2	.12
POW.	WETLOSS	2.92	1	.03
R1OW.	WETLOSS	278.54	4	2.54
UDV1O.	WETLOSS	2.47	1	.02
TOTAL (IN ACRES)		10958.9	101	100.00

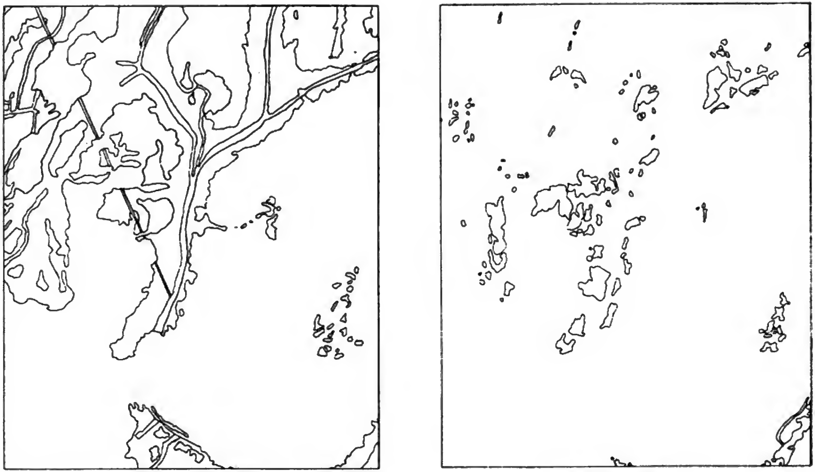
Area Summary for Map of Dixon Bay 1978, NW¼

SUBJECT		AREA	FREQUENCY	PERCENT
E1OW.	WETLOSS	10382.56	1	94.84
E2EMSP6.	WETLOSS	481.74	112	4.40
R1OW.	WETLOSS	36.69	1	.34
UDV3.	WETLOSS	8.89	2	.08
USS1S.	WETLOSS	37.06	4	.34
TOTAL (IN ACRES)		10947.0	120	100.00

Area Summary for Map of Dixon Bay 1983, NW¼

SUBJECT		AREA	FREQUENCY	PERCENT
M1OWL.	WETLOSS	1337.98	1	12.22
PEM1TPH.	WETLOSS	492.53	84	4.50
POWV.	WETLOSS	1.44	1	.01
R1OWV.	WETLOSS	9103.73	1	83.16
UBS.	WETLOSS	3.84	1	.04
USS.	WETLOSS	6.81	2	.06
UWO.	WETLOSS	.77	1	.01
TOTAL (IN ACRES)		10947.1	91	100.00

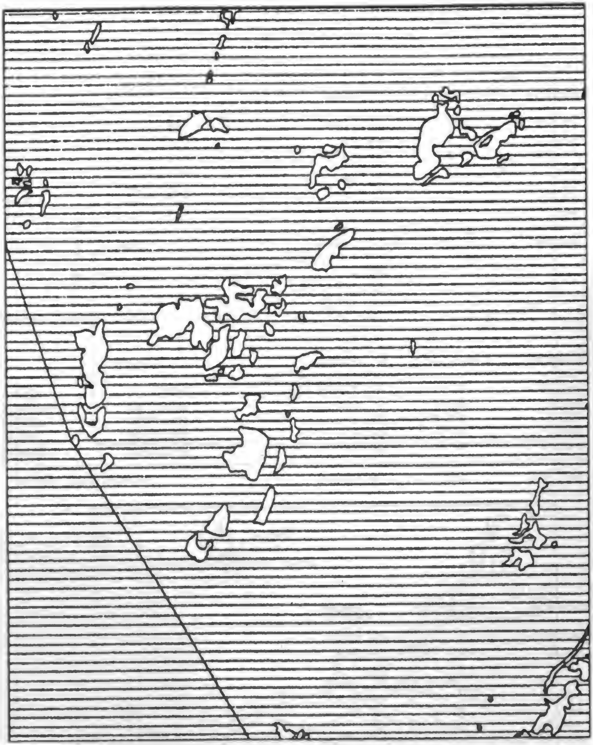
Table E-3. Area summaries for Dixon Bay, NW 1/4 for years 1956, 1978, and 1983.



Dixon Bay 1956. NW¼

Dixon Bay 1978. NW¼

Figure E-7. Mapping of 1956 and 1978 Habitat Data for Site 1.



Dixon Bay 1983, NW¼

Figure E-8. Mapping of 1983 Habitat Data for Site 1.

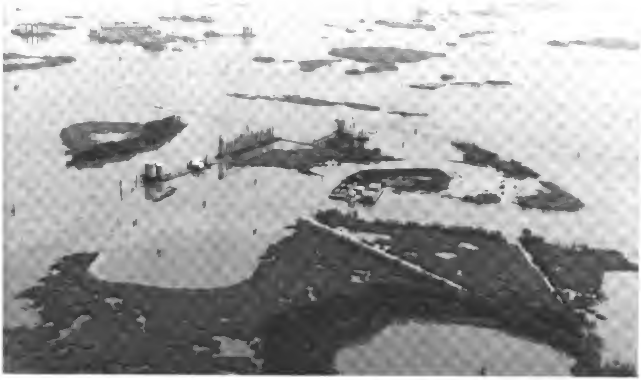


Figure E-9. Dixon Bay, NW 1/4 sample area (Site 1).

Site 2 - Pass A Loutre, West, NW $^1/4$:

Table E-4 represents the wetlands data for the years 1956 and 1976. These data and Figure E-10 illustrate that between the representative years, there was a 40.2% increase in open water areas within the sample area. Of the original 6,747.97 acres (2,730.8 hectares) of marshland within this area in 1956, some 3,978.33 acres (1,609.0 hectares) were lost to open water between these years.

As indicated at the Dixon Bay site, sediment depletion and the natural processes of subsidence and erosion are primary contributors to wetlands or land loss in the Delta region. The greatest impact to the Pass A Loutre site resulted from hurricane Camille which crossed the delta in 1969. As a result of wind and wave action, much of the flotant marsh was literally rolled up and transported out of the area. Despite the loss of much of the palustrine marsh between 1956 and 1978, much of the area has been converted to lacustrine marsh and open water for waterfowl management purposes. The sample area is currently being managed by the U.S. Fish and Wildlife Service and is a part of the Delta National Wildlife Refuge. Figure E-11 shows an aerial view of the Delta National Wildlife Refuge as it exists today. Figure E-12 shows the dense stands of roseau cane (*Phragmites communis*) that thrive within this region. Figure E-13 illustrates that marsh building (accretion) is still occurring in the modern delta through natural and man-made breaks in the levee system.

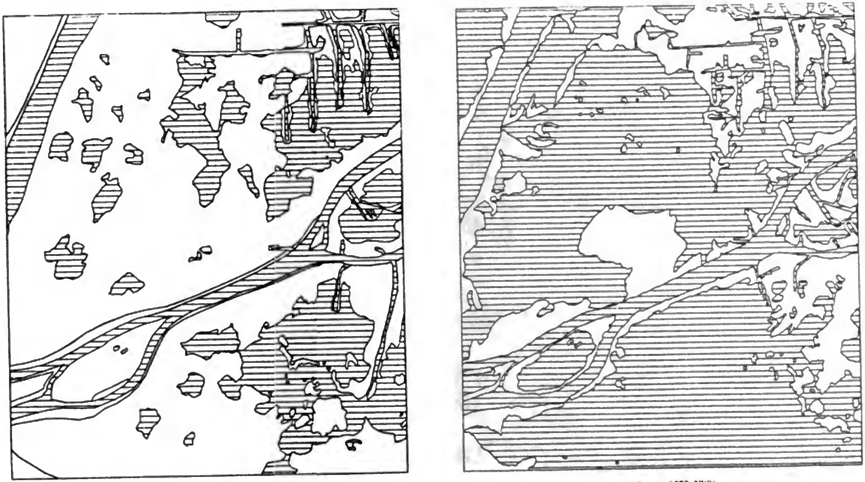
Area Summary for Map ot Pass A Loutre 1956, NW¼

	SUBJECT	AREA	FREQUENCY	PERCENT
L2OW.	WETLOSS	2155.46	17	21.79
PEM.	WETLOSS	6395.99	45	64.65
PFO1.	WETLOSS	32.16	1	.33
POW.	WETLOSS	95.49	14	.97
PSS1.	WETLOSS	242.91	7	2.46
R1OW.	WETLOSS	724.27	2	7.32
R1OWO.	WETLOSS	169.71	9	1.72
UDV1.	WETLOSS	1.08	1	.01
UDV3.	WETLOSS	70.87	16	.72
USS1S.	WETLOSS	4.94	2	.05
TOTAL (IN ACRES)		9892.9	114	100.00

Area Summary for Map of Pass A Loutre 1978, NW¼

	SUBJECT	AREA	FREQUENCY	PERCENT
L2AB.	WETLOSS	10.86	1	.11
L2AB5.	WETLOSS	12.93	3	.13
L2FL34.	WETLOSS	519.85	7	5.25
L2OW.	WETLOSS	5965.43	12	60.30
PAB.	WETLOSS	2.73	1	.03
PEM.	WETLOSS	2131.16	113	21.54
PFO1.	WETLOSS	11.39	1	.12
POW.	WETLOSS	43.86	11	.44
PSS1.	WETLOSS	39.20	5	.40
PSS13.	WETLOSS	4.89	2	.05
R1AB5O.	WETLOSS	15.70	1	.16
R1OW.	WETLOSS	900.07	3	9.10
R1OWO.	WETLOSS	214.60	4	2.17
UDV1.	WETLOSS	3.74	1	.04
UDV10.	WETLOSS	.81	1	.01
UDV3.	WETLOSS	16.41	4	.17
TOTAL (IN ACRES)		9893.6	170	100.00

Table E-4. Area Summaries for Pass A Loutre, NW 1/4 for years 1956 and 1978.



Pass A Loutre 1956, NW¼

Pass A Loutre 1978, NW¼

Figure E-10. Mapping of 1956 and 1978 Habitat Data for Site 2.

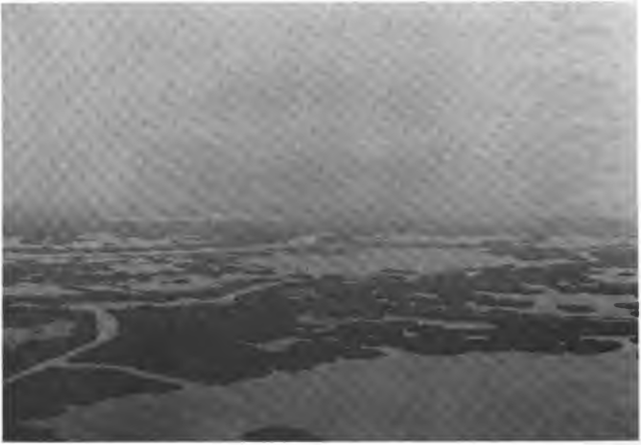


Figure E-11. Pass A Loutre, West, NW 1/4 sample area (Site 2).

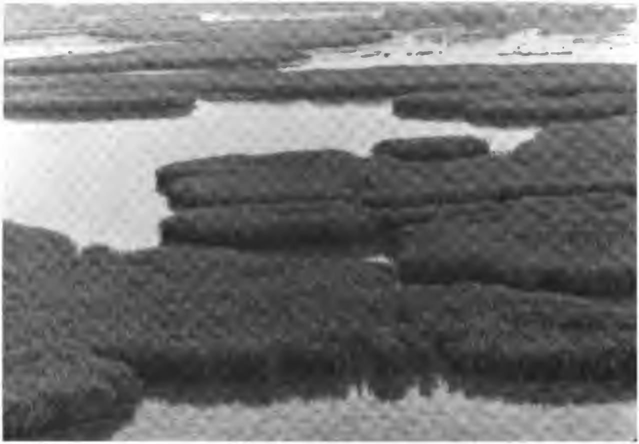


Figure E-12. Rouseau cane stands within the Delta National Wildlife Refuge area (Site 2 - lacustrine emergent marsh and open water).

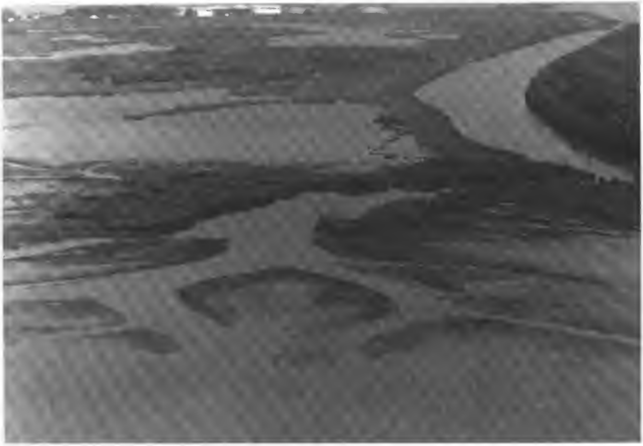


Figure E-13. Levee break (Octave Pass Area) illustrating marsh building within the modern delta.

Site 3 - Barataria SW $^1/4$:

Table E-5 represents the wetlands data for the years 1956 and 1978. These data and Figure E-14 illustrate that between the representative years, there was a 7.9% increase in open water areas within the sample area. Of the original 8,363.78 acres (3,384.7 hectares) of marshland within this area in 1956, some 872.7 acres (353 hectares) were lost to open water between these years.

Despite a marginal loss of wetlands within this area, it is interesting to note that this area has undergone a drastic change since 1956. In 1956 almost 70% of the area was palustrine emergent marsh; whereas in 1978, only 11% was of this marsh type and some 50% was of the estuarine emergent type. Likewise, in 1956, Lake Salvador was categorized as lacustrine or fresh, as opposed to 1978, when it was, and is currently estuarine. It is safe to speculate that, as a result of the opening of the Barataria and Gulf Intracoastal Waterways in this region, saltwater has intruded into the area. This action has been aided by the numerous oil and gas access canal networks within the sample area, as is shown in Figure E-15. The sample area is starting to show signs of initial marsh breakup, with the greatest loss occurring along the outer perimeter of Lake Salvador.

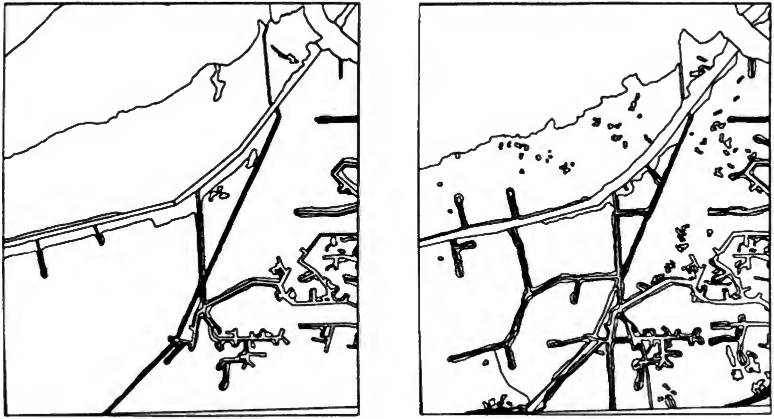
Area Summary for Map of Barataria 1956, SW¼

SUBJECT		AREA	FREQUENCY	PERCENT
E10W.	POLY	144.93	1	1.31
E10WO.	POLY	334.39	10	3.02
E10WX.	POLY	120.89	2	1.09
L10W.	POLY	122.65	2	1.11
L20W.	POLY	1890.87	1	17.06
PEM.	POLY	7783.26	12	70.24
PFO12.	POLY	16.22	1	.15
POW.	POLY	30.42	9	.27
R10WO.	POLY	6.93	2	.06
R10WX.	POLY	65.94	1	.60
UDV10.	POLY	10.30	6	.09
UF01S.	POLY	540.82	22	4.88
USS13S.	POLY	13.22	1	.12
TOTAL (IN ACRES)		11080.8	70	100.00

Area Summary for Map of Barataria 1978, SW¼

SUBJECT		AREA	FREQUENCY	PERCENT
E1AB50.	POLY	16.54	16	.15
E10W.	POLY	2758.63	71	24.90
E10WO.	POLY	513.05	19	4.63
E10WX.	POLY	317.76	2	2.87
E2EMSP6.	POLY	5586.19	23	50.41
PEM.	POLY	1191.48	3	10.75
UDV10.	POLY	.65	1	.01
UF01S.	POLY	544.26	22	4.91
USS1S.	POLY	151.96	29	1.37
TOTAL (IN ACRES)		11080.5	186	100.00

Table E-5. Area summaries for Barataria, SW 1/4 for years 1956 and 1978.



Barataria 1956, SW¼

Barataria 1978, SW¼

Figure E-14. Mapping of 1956 and 1978 Habitat Data for Site 3.

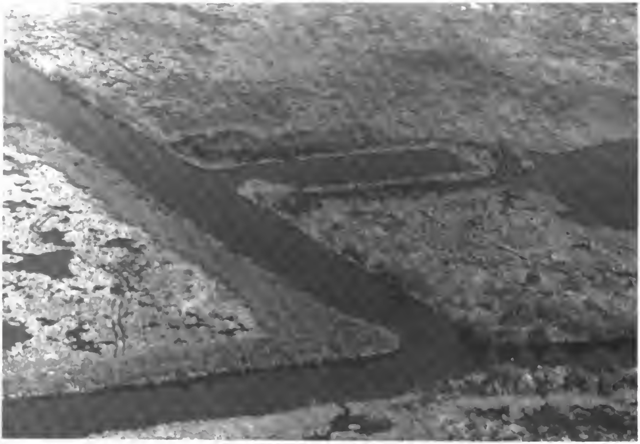


Figure E-15. Oil and gas access/dead-end canals within the Barataria, SW 1/4 sample area (Site 3).

Site 4 - Three Bayou Bay NE $^{1}/4$:

Table E-6 represents the wetlands data for the years 1956 and 1978. These data and Figure E-16 illustrate that between the representative dates, there was a 24.7% increase in open water areas within the sample area. Of the original 9,499.34 acres (3,844 hectares) of marshland within this area in 1956, some 2,754.76 acres (1,114.8 hectares) were lost to open water between these years.

Although this site is experiencing problems similar to those seen at the Barataria site, the majority of the land loss within this area stems from the physical destruction of the marsh from the building of a lattice work of oil and gas canals supporting work in the Lafitte oil and gas field, shown in Figures E-17 through E-20. In addition to the physical destruction of the marsh and resulting land loss, a massive levee system has resulted from the deposition of the spoil material rendered from the canal construction activities. This system has managed to impound much of the marsh within the area and has restricted the nutrient and sheet flow through the marsh system. As a result, much of the marsh vegetation has died off and considerable ponding has occurred. This area has been totally written off in terms of productive marsh. In the next few years, this area could be primarily open water, because not only is the marsh deteriorating here, but so is the levee system.

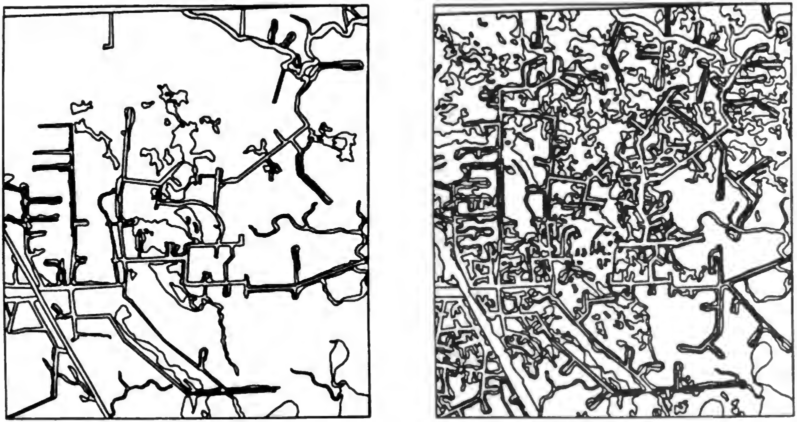
Area Summary for Map of Three Bayou Bay 1956, NE¼

```
                SUBJECT                        AREA      FREQUENCY    PERCENT
------------------------------------------------------------------------------
E10W.          OVERLAY                        821.20         20          7.39
E10WO.         OVERLAY                        649.07          9          5.84
E10WX.         OVERLAY                         65.22          1           .59
PEM.           OVERLAY                       9172.00         44         82.54
PFO123.        OVERLAY                          5.30          1           .05
POW.           OVERLAY                         77.47         11           .70
UDV1.          OVERLAY                         31.60          2           .28
UDV3.          OVERLAY                        199.60         40          1.80
UFO1S.         OVERLAY                         68.52         13           .62
USS13S.        OVERLAY                         22.28          4           .20
------------------------------------------------------------------------------
 TOTAL (IN ACRES)                            11112.3        145        100.00
```

Area Summary for Map of Three Bayou Bay 1978, NE¼

```
                SUBJECT                        AREA      FREQUENCY    PERCENT
------------------------------------------------------------------------------
E10W.          OVERLAY                       2704.05        108         24.34
E10WO.         OVERLAY                       1485.68         19         13.37
E10WX.         OVERLAY                        174.89          1          1.57
E2EM5P5.       OVERLAY                       5286.98        136         47.59
E2EM5P5D.      OVERLAY                         22.29          1           .20
UDV1.          OVERLAY                         11.83          2           .11
UDV10.         OVERLAY                         24.27          2           .22
UDV3.          OVERLAY                         28.97          7           .26
UFO1S.         OVERLAY                        195.08         20          1.76
USS1S.         OVERLAY                       1175.20        154         10.58
------------------------------------------------------------------------------
 TOTAL (IN ACRES)                            11109.2        450        100.00
```

Table E-6. Area summaries for Three Bayou Bay, NE 1/4 for years 1956 and 1978.



Three Bayou Bay 1956, NE¼

Three Bayou Bay 1978, NE¼

Figure E-16. Mapping of 1956 and 1978 Habitat Data for Site 4.

Figure E-17. Aerial view of the Three Bayou Bay, NE 1/4 sample area (Site 4).

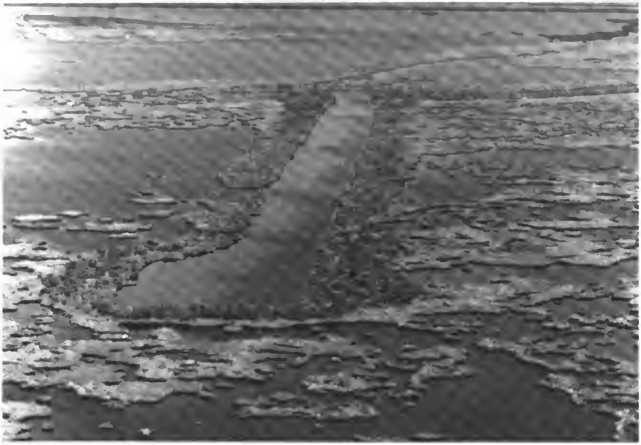


Figure E-18. Marsh deterioration around dead-end canal within Three Bayou Bay site area.

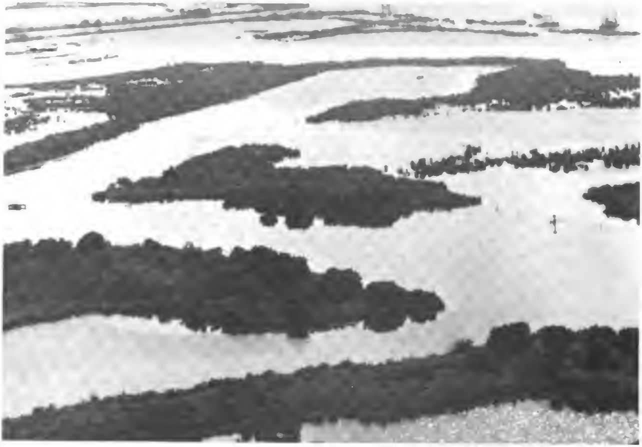


Figure E-19. Illustration of canal density and levee deterioration within Site 4 area.

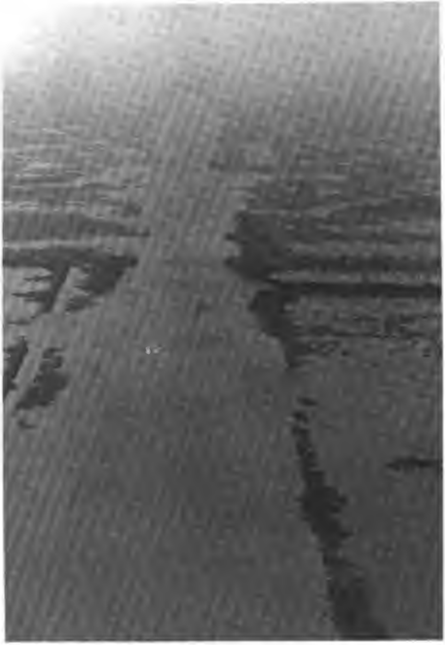


Figure E-20. Aerial view of the Barataria Waterway within the Site 4 area. Illustrates erosional/edge effect along this waterway due to vessel traffic and other factors.

Site 5 - Five Lakes SE $^1/4$:

Table E-7 represents the wetlands data for the years 1956 and 1978. These data and Figure E-21 illustrate that between the representative years, there was a 33.9% increase in open water areas within the sample area. Of the original 10,281 acres (4,160.5 hectares) of marshland within this area in 1956, some 3,645.59 acres (1,475.3 hectares) were lost to open water between these years.

As was the case with the Pass A Loutre, West sample site, the Five Lakes site is currently managed by the U.S. Fish and Wildlife Service (USFWS) as a part of the Sabine National Wildlife Refuge. The outstanding feature to this area, as shown in Figure E-22, is a large freshwater impoundment managed and controlled by USFWS. As is seen in the data from 1956 only 1.87% of the sample area was lacustrine open water; however, the 1978 data reflects the efforts of USFWS and a 24% increase in lacustrine open water areas within the site. As was stated previously, this marsh type supports the greatest diversity of plants which are preferred foods of wildlife. The cause of marsh break up around the impoundment area is currently unknown; however, it is speculated that the area has become impounded as a result of a series of levees and ridges within the area, thereby restricting sheet flow throughout these areas.

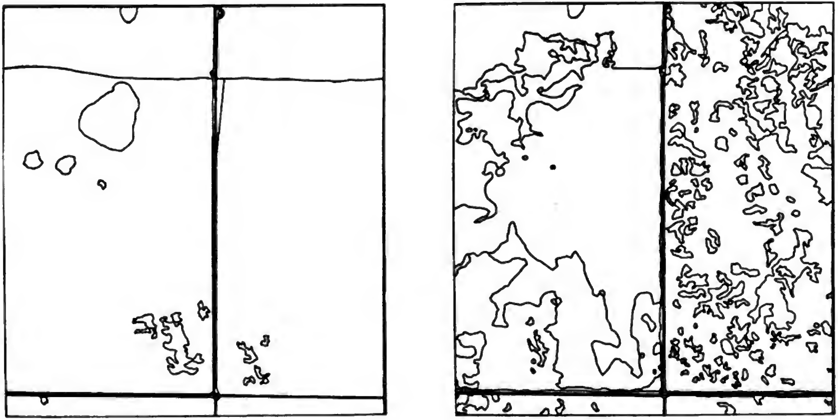
Area Summary for Map of Five Lakes 1956, SE¼

```
               SUBJECT                            AREA       FREQUENCY     PERCENT
-----------------------------------------------------------------------------------
 E1OW.          OVERLAY                          123.66          8            1.15
 E1OWX.         OVERLAY                           93.24          1             .87
 E2EM.          OVERLAY                         4105.04          7           38.25
 E2EMM.         OVERLAY                         4289.43          1           39.97
 L2OW.          OVERLAY                          200.15          2            1.87
 PEM.           OVERLAY                          845.34          3            7.88
 PEMM.          OVERLAY                          975.04          1            9.09
 POW.           OVERLAY                           33.55          3             .31
 UDV1.          OVERLAY                           66.21          1             .62
-----------------------------------------------------------------------------------
 TOTAL  (IN ACRES)                              10731.6         27          100.00
```

Area Sunnmary for Map of Five Lakes 1978, SE¼

```
               SUBJECT                            AREA       FREQUENCY     PERCENT
-----------------------------------------------------------------------------------
 E1OW.          OVERLAY                         1172.07        117           10.92
 E1OWX.         OVERLAY                           95.39          2             .89
 E2EM5P5.       OVERLAY                          193.80          1            1.81
 E2EM5P6.       OVERLAY                         3609.99          9           33.64
 L2AB5H.        OVERLAY                         1211.40          5           11.29
 L2OWH.         OVERLAY                         2822.84          7           26.31
 PEMM.          OVERLAY                         1498.19         16           13.96
 POW.           OVERLAY                            3.51          2             .03
 POWH.          OVERLAY                            1.48          2             .01
 UDV1.          OVERLAY                           53.51          1             .50
 USS1S.         OVERLAY                           68.53          4             .64
-----------------------------------------------------------------------------------
 TOTAL  (IN ACRES)                              10730.7        166          100.00
```

Table E-7. Area summaries for Five Lakes, SE 1/4 for years 1956 and 1978.



Five Lakes 1956, SE¼

Five Lakes 1978, SE¼

Figure E-21. Mapping of 1956 and 1978 Habitat Data for Site 5.

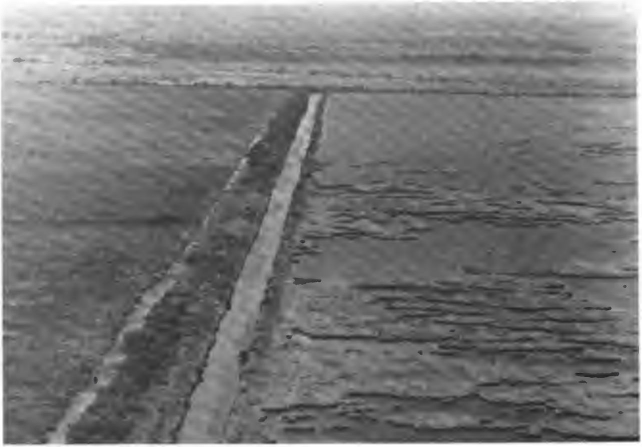
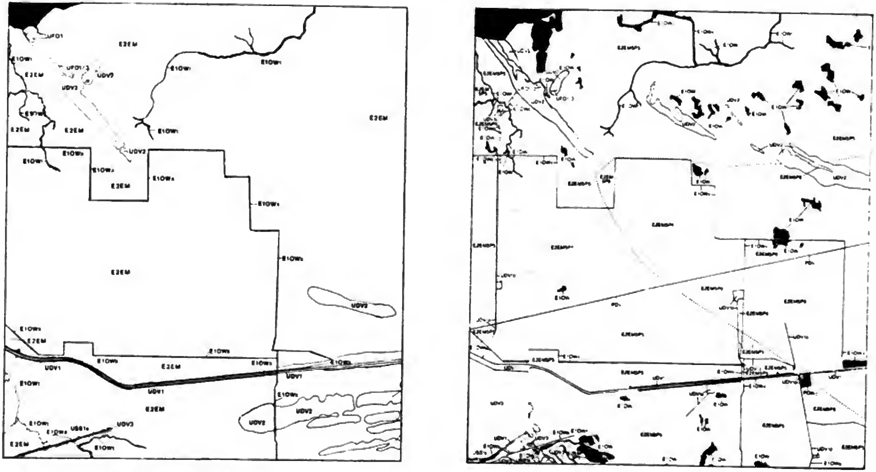


Figure E-22. Right half of the photograph shows a portion of the freshwater impoundment area managed by USFWS in Five Lakes, SE 1/4 area (Site 5).

Site 6 - West of Johnson's Bayou SW $^1/4$:

Although we were unable to obtain the necessary data from USFWS to calculate the percent of loss within the area, it can be seen from Figure E-23 that very little of the marsh area has been lost to open water between 1956 and 1978. This site is predominantly a natural grassy estuarine marsh that abounds with wildlife (Figure E-24). Aside from a small percent of the area being used for grazing land, the only human influence within the area is restricted to a dredge spoil depository (dump site) located in the SW portion of the site and is utilized by the U.S. Army Corps of Engineers.



West of Johnson's Bayou 1956. SW¼

West of Johnson's Bayou 1978. SW¼

Figure E-23. Mapping of 1956 and 1978 Habitat Data for Site 6.

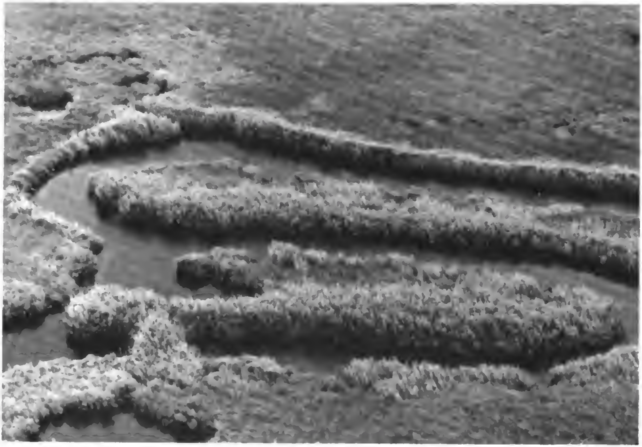


Figure E-24. Marshy region representative of the West of Johnson's Bayou area (Site 6).

Appendix F

Deepwater Technology

TABLE OF CONTENTS

Page

Introduction F-5
Exploratory Drilling F-5
Mooring vs. Dynamic Positioning F-8
Marine Riser System F-11
Blowout Preventer Controls F-11
Guidelineless Re-entry F-14
Drilling in Currents F-14
Exploratory Well Records F-14
Completion and Production F-15
Transportation F-23
Summary and Conclusion F-28
References F-30

LISTS OF FIGURES AND TABLES

Tables

F-1 Comparison of Ship and Semi-submersible Drilling Units F-6

Figures

F-1 Simple Pneumatic Compensator System F-7
F-2 Systems for Dynamic Positioning F-9
F-3 Taut-wire Schematic F-10
F-4 Marine Riser Assembly F-12
F-5 Simplified Subsea Blowout Preventer (BOP) F-13
F-6 Wet Subsea Completion F-16
F-7 Dry Subsea Completion F-17
F-8 Cognac Platform, Offshore Louisiana F-19
F-9 Design, Fabrication, and Installation Cost Versus Water Depth F-20
F-10 Guyed Tower F-21
F-11 Tension-Leg Platform F-21
F-12 Free-Standing Riser F-24
F-13 Exxon Articulated Riser F-25
F-14 Industry Pipeline Capability Projection F-26
F-15 Conventional Pipelaying F-27
F-16 Vertically-laid Pipeline in Deepwater F-29

INTRODUCTION

As the "easily accessible" hydrocarbon resources onshore and in shallow water are exploited, the industry must explore in deeper and more hostile environments to help meet society's need for energy. Oil and gas development in these environments will require the use of new equipment suitable for working at such depths; however, the major factor determining the ability to produce oil and gas in deepwater is economics. In order to justify the drastically increased cost of operating in deeper water, substantial reserves must be found, especially in consideration of the current worldwide depressed price of oil. Drilling of exploratory wells to date has been limited to water depths shallower than 2,119 m (6,952 ft).

Exploitation of hydrocarbon reserves occurs in several stages: exploratory drilling, development drilling, and establishment of production facilities; and transportation of the products.

EXPLORATORY DRILLING

The rigs most commonly used for exploratory drilling are jack-ups, semi-submersibles, and drill ships. Jack-up rigs are limited in water depth by the length of the legs, 40-120 m (130-400 ft) maximum. Semi-submersibles and drill ships are most commonly used for deepwater drilling.

Semi-submersible drilling rigs, also known as column-stabilized drilling units, provide a much larger deck space than drill ships but offer substantially less storage capacity in terms of weight. This is due to the much smaller waterplane area of semi-submersibles as compared to drill ships. Semi-submersible vessels have excellent motion characteristics; roll seldom exceeds 5° on a properly found vessel, even in the most severe seas. Most of the semi-submersible drill units utilize conventional catenary mooring systems, which is one of the limiting factors in water depth capability. At present, there are approximately 11 semi-submersibles capable of drilling in water depths of 450-610 m (1,475-2,000 ft), 17 are capable of operating in depths of 610-760 m (2,000-2,500 ft), and 4 have water depth capability of 1,800 m (5,900 ft) (International Petroleum Encyclopedia, 1983).

Due to the load capacity resulting from the greater waterplane area of the hull, drilling ships in general have greater capabilities for drilling in deeper water. For deep drilling from a floating vessel, the blowout preventer (BOP) stack and well controls must be placed on the seafloor. If retrieval of the riser is necessary, the retrieval of all drilling mud in the riser may be necessary. Most drill ships have a greater mud storage capacity than semi-submersible vessels (Table F-1).

The deepest exploration well drilled to date was in 1984 by the drill ship DISCOVER SEVEN SEAS off New Jersey in 2,119 m (6,952 ft). Drill ships, such as the SEDCO 445, SEDCO 472, DISCOVERER 534, DISCOVERER SEVEN SEAS, and NEDDRILL 2 are designed to drill in waters up to 2,440 m (8,000 ft) deep. Most of these types of vessels utilize dynamic positioning systems, although some use conventional catenary mooring systems as well. One drill ship, the GLOMAR CHALLENGER, has drilled in water more than 6,100 m (20,000 ft) deep. This vessel, however, was involved in scientific sampling and drilled without a BOP and riser and, therefore, purposely avoided any potential oil and/or gas prone areas. Another vessel, the "Resolution", registered as the SEDCO 471, is equipped to drill in more than 8,230 m (27,000 ft) of water, and is currently involved in the Deep Ocean Drilling Program carried out by JOIDES (Joint Oceanographic Institutes for Deep Earth Sampling), and funded by the National Science Foundation and Joint Oceanographic Institute, Inc. The "Resolution" also purposely avoids hydrocarbons since seawater is used for drilling fluid and vessel uses no riser.

Floating drill units make up a majority of today's mobile offshore fleet. Drilling from a floating platform is very different from drilling on a bottom-supported platform or onshore and requires some very specialized equipment. In any type of drilling, the ability to keep a constant preselected weight on the drill bit is extremely important. To counteract the up and down movement of waves, all floating units have some sort of heave compensator. These units are attached to the traveling block or crown block, and through the use of high pressure air or air/oil, the loads caused by the rise and fall of the vessel are balanced out (Figure F-1).

Additional problems are posed by the riser system in a floating drilling operation since it must also allow for the up and down movement of the waves. This problem is mitigated through the use of slip-joints in the riser itself and a riser tensioning system which operates similarly to the heave compensator previously described. If guidelines leading to the subsea BOP and wellhead are used, they also have similar tensioning systems.

Another piece of equipment common to floating rigs is the traveling block guide rails and dolly. This equipment keeps the traveling block, which hangs from the crown block on the derrick, centered over the rotary table

Table F-1

Comparison of Ship and Semi-submersible Drilling Units

	Ship Units	Semi-submersibles
Approximate Number Operating	54	119
Initial Cost (1980)	$5-65 million	$5-81 million
Displacement (long tons)		
Smallest	5,000	8,000
Largest	36,000	39,000
Normal	11,000	14,000-25,000
Travel/Towing Speed (knots)	6-12	3-10
Natural Roll Period (sec)	8-14	18-33

Typical Storage Capacities of Larger Units
(long tons except as noted)

Tubular Goods	1,270	490
Sack Mud and Cement	540 (12,000 sx)	230 (5,000 sx)
Bulk Mud and Cement	230 (5,000 sx)	180 (6,100 sx)
Liquid Mud	680 (3,000 bbls)	200 (900 bbls)
Fuel	1,100 (8,150 bbls)	610 (4,460 bbls)
Drilling Water	2,400 (15,000 bbls)	1,450 (9,100 bbls)
Potable Water	80 (500 bbls)	50 (330 bbls)
Approximate Water Capacity	6,300	3,300 (due to a smaller water plane area)

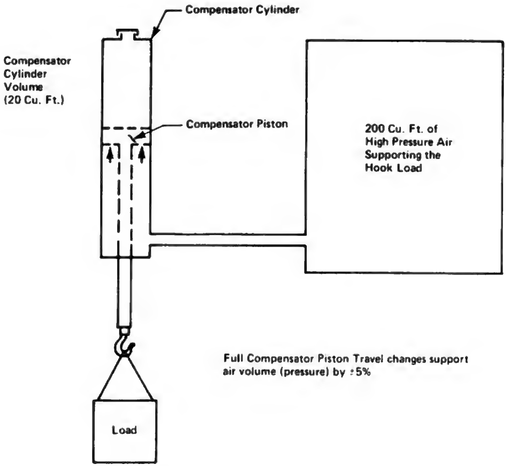

Compensator Cylinder
Compensator Cylinder Volume (20 Cu. Ft.)
Compensator Piston
200 Cu. Ft. of High Pressure Air Supporting the Hook Load
Full Compensator Piston Travel changes support air volume (pressure) by ±5%
Load

Figure F-1. Simple Pneumatic Compensator System and the hole. In addition, floating rigs sometimes have power-assisted pipe racking while bottom supported rigs do not.

Several major design innovations were necessary to allow shallow water drilling technology to be applied to sites in deeper water. Among these were:

- dynamic positioning
- marine riser systems
- electrohydraulic blowout preventer (BOP) controls
- re-entry procedure for guidelineless drilling

MOORING VS. DYNAMIC POSITIONING

Mooring systems were a critical factor in the ability to drill in deeper waters. Today's drilling vessels are able to weather most any storm, but the mooring systems are not.

In moderate water depths, chain gives a better catenary action than wire rope. However, in water depths greater than 305-360 m (1,000-1,200 ft), the weight and volume of the bulky chain makes its use prohibitive. In greater water depths, a combination chain and wire rope system is used.

For example, chain commonly used is 2-inch or 2 3/4-inch. The 2-inch chain weighs approximately 40 pounds per foot and the 2 3/4-inch weighs 75-80 pounds per foot. Wire rope commonly used is 6 x 37 in diameters ranging from 2 to 3 1/2 inches. The 2 1/2-inch wire rope runs approximately 11.6 pounds per foot. For 455 m (1,500 ft) water depths, the horizontal distance from the anchor to the rig in a standard mooring configuration would be approximately one mile. Along the catenary, the distance would be approximately 1,830 m (6,000 ft); therefore, 915 m (3,000 ft) of 2 1/4-inch wire rope weighs about 34,800 pounds for a total of 154,800 pounds for each of up to eight moorings on the rig.

With just wire or chain, 305 m (1,000 ft) water depth is about the maximum at which a vessel may anchor and drill. Beyond this depth, the mooring system is stressed to the point it can support only its own weight. With the combination system, this maximum depth can be extended out to around 1,500 m (4,920 ft). To date, this system has been proven in only about 1,000 m (3,280 ft) or less. Besides the weight of the mooring system stressing itself, another factor which limits the water depth in which a mooring can be used is the horsepower rating of anchor handling vessels used to extend the anchors out around the rig.

Dynamic positioning systems use thrust to maintain the vessel on station over the subsea well. Using dynamic positioning, drilling operations can continue in 60-knot winds plus a 3-knot current.

There are approximately 20 drilling vessels equipped with dynamic positioning systems. The SEDCO 445 was the first dynamically positioned drill ship and went into service in 1971 (Albers, 1980). The SEDCO 709 can carry supplies and equipment to drilling water up to 2,440 m (8,000 ft) and can continue drilling in 66-knot winds, 17 m (56 ft) waves, and 2.4-knot currents.

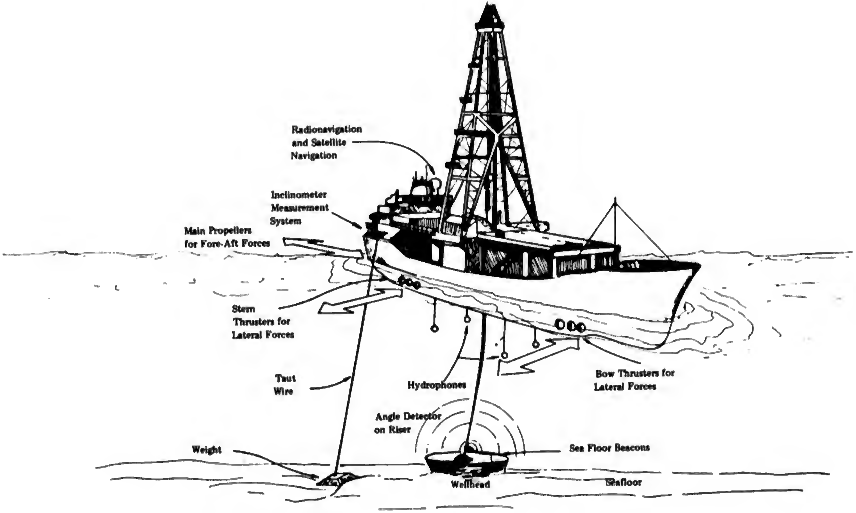
There are now four semi-submersibles equipped with dynamic positioning: HENRY GOODRICH, SEDCO 709, SEDCO 710, and OCEAN ALLIANCE (Offshore, 1983a).

Dynamic positioning systems typically consist of four elements: sensors, controller, propulsion, and power plants.

A number of different types of sensor systems are used to detect movement off station, and usually each system has more than one sensor (Figure F-2). Seafloor beacons are placed at or near the wellhead or the seafloor. An array of hydrophones is placed on the drill vessel and feeds into the control computer. Based on time delay, the vessel's position with reference to the beacons (and thus the wellhead) is calculated. A very similar system which operates on the same principle utilizes transponders on the seafloor and surface transmitting interrogators on the drill ship. The latter system also uses four receiving hydrophones.

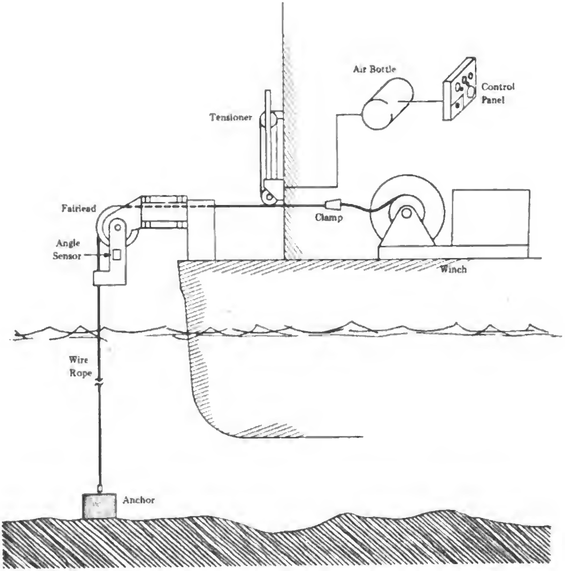
Another sensor which feeds into the computer which controls the thrusters is a taut wire system. A weight is lowered to the seafloor, and the wire attached to it is drawn tight (Figure F-3) and maintained at a constant tension. An angle sensor is attached to the taut wire and feeds the angle and direction to the computer if the wire gets out of a vertical attitude. A similar system is attached to the riser pipe.

A vertical reference unit is also fed into the computer. This unit consists of a vertical gyro and measures pitch and roll. Other inputs which can be fed into the positioning system include radio and satellite navigation, wind


Radionavigation and Satellite Navigation
Inclinometer Measurement System
Main Propellers for Fore-Aft Forces
Stern Thrusters for Lateral Forces
Taut Wire
Hydrophones
Bow Thrusters for Lateral Forces
Angle Detector on Riser
Weight
Sea Floor Beacons
Wellhead
Seafloor

Source: Delco Electronics

Figure F-2. Systems for Dynamic Positioning



Source: Delco Electronics

Figure F-3. Taut-wire Schematic

sensors, gyrocompass, inertial reference unit, and if used in conjunction with catenary mooring, tension-meters. A "joystick," which can manually adjust or override the dynamic positioning, is also available in the control room.

The controller consists of the computer system which integrates all the input from the different sensors. There are two independent controller units; should one fail, the other is automatically switched in. The computer which is "on line" also checks incoming information for electrical failures, logic failures, or computational discrepancies. All information is processed and command signals are sent to the appropriate thrusters to apply the proper force in the proper direction to keep the vessel over the well. The computer also has built-in filtering to automatically adjust for sea-wave induced spectrum of vessel motion.

Most vessels use the main propellers for fore and aft forces; thrusters are used for port and starboard forces. Many variables are used in the design of the thrusters. Most range in size from 800 to 2,500 horsepower. Two basic types of thrusters are azimuth and fixed. The azimuth thrusters can be rotated to point the resultant force in the desired direction. The lateral fixed type has performed very satisfactorily in connection with the vessel's main propellers.

Some thrusters are mounted in tunnels through the hull and others are mounted below the hull. Some thrusters have continuously turning controllable-pitch propellers while others use controllable reversing motors. The thrusters are usually mounted with two or more near the bow and two or more near the stern. They are positioned to maximize the ability of keeping the bow of the vessel headed into the worst environmental conditions.

Power systems used to date have been diesel/generator systems. Several large generators (up to eight) are used to supply peak power to not only propulsion systems, but to drilling and support systems as well. Vessels are designed to have one generator over and above those required to meet peak loads. In the case of the SEDCO 709, these generators provide some 26,000 horsepower. Fuel usage on a vessel such as this in the dynamically positioned mode averages around 7,000 gallons per day. Under extreme conditions, as much as 11,000 gallons per day may be consumed (Grief, 1985).

MARINE RISER SYSTEM

When drilling in deepwater, the riser itself presents some special problems and is generally the limiting factor in deepwater exploratory drilling capability. Risers are designed to be held in tension to preventing buckling. In shallow water, tension can be maintained by the drill vessel from above. In deepwater, however, the marine riser must support the column of heavy drill mud inside it; therefore, very strong and heavy pipe is required (usually grade X-52 or HY-80, up to 80,000 psi minimum yield strength) and keeping this weight in tension presented a problem. This problem was solved by attaching special buoyancy elements to the riser (Figure F-4). Another problem that surfaced was that under the compression of water pressure at great depth the buoyancy elements lost some of their effectiveness. A firm (Emerson and Cuming), however, has now designed and tested marine riser buoyancy modules for 3,650 m (11,975 ft) of water. Syntactic foam modules rated to 2,740 m (8,990 ft) are now operational.

Another riser-related weakness which in the past has hampered deepwater drilling was in the coupling. Couplings were only about one-half as strong as the riser pipe and were frequently the cause of failures. Several new couplings have been developed which are of greater strength than the body of the riser.

The riser is connected to the subsea wellhead through a flex-joint, which allows up to 10° of angular movement of the riser with respect to the wellhead (Figure F-4). In general, operations are terminated if the flex-joint angle exceeds 3.5°.

One detail shown in Figure F-4 is the diverter system which is below the slip-joint. If high-pressure gas is encountered in the shallow subsurface and the well is shut in, the escaping gas might crater out around the conductor pipe. Therefore, the gas would be allowed to come up the riser and divert out to the side of the drilling vessel.

BLOWOUT PREVENTER CONTROLS

The BOP is a device through which wells are drilled to prevent high pressure gas or oil from getting out of control and blowing back out of the hole. The BOP consists of three or more hydraulic pipe rams near the bottom which can seal around the drill pipe (Figure F-5). The upper set of rams are the shear rams. These rams shear off the drill pipe and seal the hole. Usually above the shear rams is a device called an annular preventer, which is a "doughnut" shaped packer or bladder which can be hydraulically inflated to seal off around any tubular which might pass down through it. There is also a choke and kill system which utilizes two lines that go into the BOP at a level

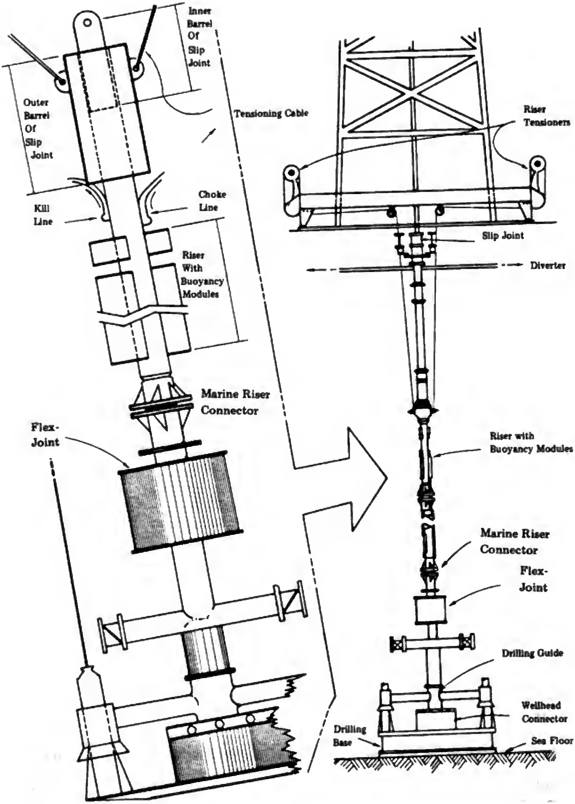


Figure F-4. Marine Riser Assembly

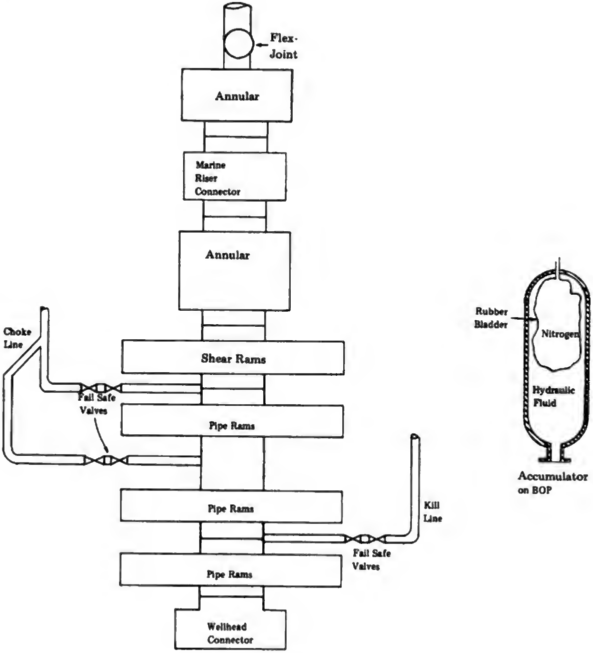


Figure F-5. Simplified Subsea Blowout Preventer (BOP) below some of the rams. One, the "kill line," is used to pump heavy fluids down the hole to force any high pressure oil or gas back into the formation to "kill" the well. The second, the "choke line," is used to circulate, with control, drilling fluids in the well when the BOP is shut-in (when the rams are closed). The BOP used in deepwater drilling is placed on the seafloor and is attached to the wellhead via a hydraulically actuated connector. Most BOP systems are rated to about 10,000 pounds per square inch (psi). The BOP's must also be designed to withstand the tremendous loads imposed on it by the marine risers. For example, the BOP's found on several SEDCO ships are 11.8 m (39 ft) high and weigh about 400,000 pounds (Drucker, 1982).

Rapid response of the rams is often vital in controlling a kick. In shallow water or onshore, simple hydraulic systems offer adequate response times. However, in deepwater, this response time is too long. For example, to close the BOP rams in 1,800 m (5,900 ft) of water with a conventional control system might require around 65 seconds. To alleviate this problem, an electrohydraulic BOP control system has been developed which utilizes electricity to operate pilot valves to direct the hydraulic power fluids. The response time in this system is reduced to about 23 seconds. A further refinement of the electrohydraulic system is used in ultra-deepwater and involves the use of multiplexed electrical signals. This system reduces the size of electrical cable needed from about 2-inch outside diameter (OD) to about 1-inch OD and can handle some 100 separate functions as opposed to about 40 functions for the multiconductor system (Hammett, 1979).

To attain instant response when the pilot valves are actuated, reserve accumulators are often used on the BOP (Figure F-5). These are high pressure metal bottles which contain a rubber bladder. To charge one, the rubber bladder is prepressured with nitrogen. The tank is then filled with the hydraulic fluid, and the rubber bladder is compressed to a pressure of around 3,000 psi.

GUIDELINELESS RE-ENTRY

In shallow water drilling, guidelines are used to guide the BOP, lower marine riser package, etc., down to the wellhead. In deepwater, the weight of the guidelines themselves make them prohibitive. Therefore, a re-entry technique was developed using acoustic (sonar) instruments and underwater TV systems without guidelines to find and re-enter the wellhead. Using its guidelineless re-entry system, the SEDCO 471 found and re-entered a hole in 4,876 m (16,000 ft) of water in the Atlantic Ocean abandoned by the GLOMAR CHALLENGER (Grief, 1985).

DRILLING IN CURRENTS

Strong currents that further complicate the intricate task of re-entering a subsea wellhead in deepwater are often encountered at drilling sites all over the world. In 1978, Sedco's drill ship SEDCO 472 completed an exploratory drilling program for Esso Exploration in a deepwater area off the northern coast of South America where the South Equatorial Current flows from east to west approximately parallel to the coastline. The deepest water depth drilled was 1,200 m (3,937 ft) and surface currents of 3 knots were encountered. In order to successfully complete the drilling program, an intensive research and engineering effort was undertaken to successfully solve some new problems that this environment presented (Shanks et al., 1979).

EXPLORATORY WELL RECORDS

As technology advances, deepwater exploration drilling records are being broken almost yearly. In 1969, Exxon drilled several wells in waters deeper than 300 m (984 ft), one of which was in almost 400 m (1,312 ft) of water off California. In 1970, Exxon drilled another well off California in 456 m (1, 496 ft). Shell broke Exxon's record with a well drilled off Gabon in some 633 m (2,077 ft) of water in 1974. Shell drilled another well in the same area at a depth of 698 m (2,290 ft) in 1975. Then in 1976, the water depth record was extended to 1,055 m (3,461 ft) by Esso Exploration off Thailand. In 1977, Esso Exploration broke their own depth record with a well drilled off Surinam in 1,204 m (3,950 ft). Getty, as operator for the Seagap Group and Hydro-Congo, extended the water depth record to 1,324 m (4,345 ft) off the coast of Congo in 1978. Again, in 1979, Getty established a new record with a well in the Mediterranean off Barcelona, Spain, in 1,353 m (4,439 ft) using the drill ship DISCOVERER SEVEN SEAS. Getty's record did not last for long. On April 28, 1979, Texaco, along with several other companies, spudded a well with the DISCOVERER SEVEN SEAS in 1,486 m (4,875 ft) of water off St. Johns, Newfoundland. In 1982, the DISCOVERER SEVEN SEAS spudded a well in 1,714 m (5,624 ft) of water off France in the Gulf of Lion

(Offshore, 1983b). In 1983, DISCOVERER SEVEN SEAS spudded a well in 1,965 m (6,448 ft) of water on Wilmington Canyon Block 587 off the U.S. east coast, besting the previous water depth record by 251 m (824 ft) (Petroleum Engineer International, 1983). The DISCOVERER SEVEN SEAS again advanced the record in 1984 when Shell drilled in the Wilmington Canyon Area off the New Jersey Coast in 2,119 m (6,952 ft).

COMPLETION AND PRODUCTION

The major limiting factor in the exploitation of hydrocarbon reserves in deepwater is not in drilling, but in completion and production. Two methods of production are possible in deepwater. One concept utilizes subsea completions and the other uses compliant platforms.

Subsea completions may be necessary in water depths too great for conventional platforms, and perhaps for some compliant structures. Subsea completions also augment conventional platforms by: (1) developing parts of smaller structures and allowing gas or water injection in the periphery of a reservoir; (2) allowing the development of fields not economically viable with a conventional platform; and (3) providing early production allowing improved initial cash flow.

The first known underwater completion in North America was made in 1943 in Lake Erie. Since then, over 300 subsea completions have been made in Lake Erie in less than 26 m (85 ft) of water. Subsea production technology has been under development since the early 1960's in the Gulf of Mexico. These wells are controlled by hydraulic or electrohydraulic systems, serviced with pressure activated tools through the flowline (TFL), and have downhole automatic shut-in systems. Some 334 subsea completions have been made worldwide, several of which are in slightly more than 305 m (1,000 ft) of water. Of these, some 53 wells have been completed which utilize TFL servicing (Hanson, 1985).

In completing most of the wells, the equipment used required divers. Man's diving capabilities in deepwater are quite limited. Although submersible vessels exist that provide a l-atmosphere environment for man to any depth, his ability to perform mechanical task remotely is limited. For such tasks, divers are required. The French diving company, COMEX, set an open ocean, deep-diving record in October 1977 in the Mediterranean Sea off the south of France. COMEX and French Navy divers were saturated in a helium-oxygen breathing mixture and lowered in a chamber to a depth of 430 m (1,411 ft) where they made a total of 10 hours of working dives during which a 9-inch pipeline connection was made. Two divers, one from COMEX and one from the French Navy, made two 10-minute bounce dives to a record depth of 501 m (1,644 ft). Decompression time from 430 m (1,411 ft) to the end of saturation was just over 7 days and 17 hours.

The hyperbaric facility at Duke University in North Carolina, under the direction of Dr. Peter Bennett, set a world depth record for chamber dives in February 1981. Divers were pressured up to a simulated depth of 686 m (2,251 ft), remained at that depth for 24 hours, and were safely returned to surface pressure.

In order to reduce the need for divers, techniques have been developed for installation of subsea completions from surface vessels. There are two types of subsea completions now in use. The first type, called a wet tree, consists of either a single wellhead or multiple wellheads on or below the ocean floor on a template (Figure F-6). The second system consists of a wellhead enclosed in a chamber at one atmosphere of pressure (Figure F-7). The chamber allows a man to work on the well in a shirt-sleeve environment. The advantage to the dry completion is the well control lines and the flowline can be connected from inside the chamber. The wet tree requires connections to be made on the outside by a diver, submersible, or surface guideline - a costly proposition in deepwater depths. Water depth is not a critical factor in the dry completion because the wall thickness of the chamber can be increased to withstand greater pressure.

Research and field testing has led to the commercial development of wet subsea production systems technology now available for water depths of 1,525 m (5,000 ft) or more.

Wet tree completions have been installed and are in production in various parts of the world. One system, shown in Figure F-6, is in use in the Casablanca Field in the Mediterranean Sea south of Barcelona, Spain, in 120-150 m (394-492 ft) of water. The system is designed for diverless installation with manipulator back-up. The installation of this system was accomplished without diver assistance. A tubing head adapter with four guide posts was lowered down the four guidelines attached to the existing subsea wellhead. This unit was then locked into place hydraulically and pressure tested. Then, a modified BOP stack was lowered on the guidelines and guided into position by the guide posts. It was then locked down onto the tubing head adapter with hydraulics. At this point, the the tubing hanger, downhole equipment, and well tubing were installed and the well was temporarily plugged. The

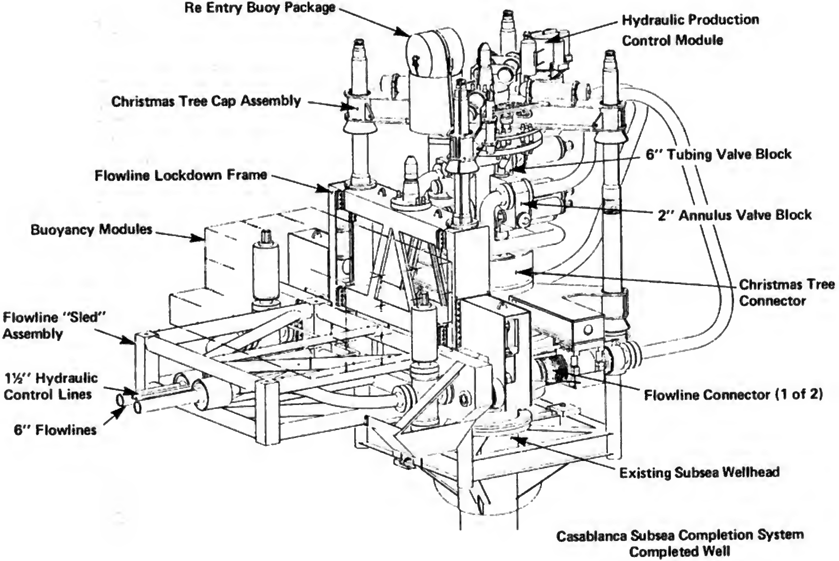


Figure F-6. Wet Subsea Completion

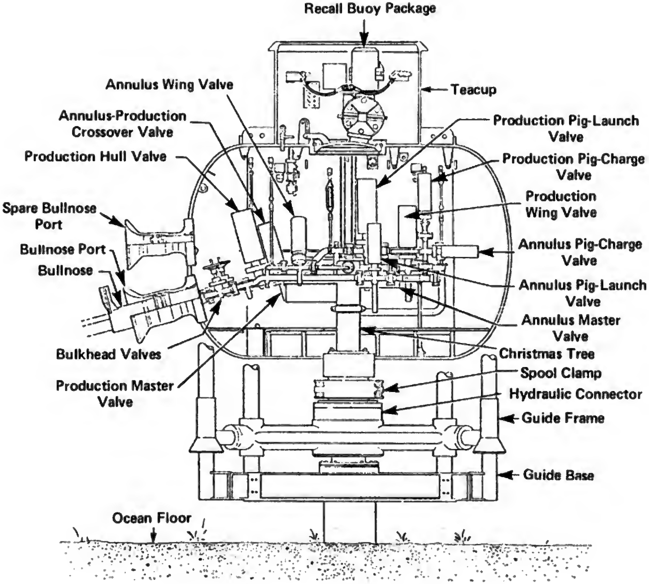


Figure F-7. Dry Subsea Completion

BOP was then removed and the Christmas tree (wellhead) assembly was run, landed, and locked into place and tested. A lower riser package containing hydraulically-operated completion and workover controls was used to attach the Christmas tree assembly, and after the assembly was in place, the lower riser package was retrieved. A flowline pull-in tool and lockdown frame were then lowered and locked into place on two of the guide posts. The flowlines were connected to a "sled" which was attached to wire ropes from the pull-in tool and the sled, with the flowlines, was pulled into position in the lockdown frame. Hydraulically-actuated wedges were driven home locking the sled to the lockdown frame. The wires were cut off remotely and the pull-in tool was retrieved. The lower riser package was relowered and locked into place on top of the Christmas tree. Flowline connectors were extended, locked, and pressure tested. Both tubing plugs were pulled and the well was brought into production. When servicing is required, a pop-up buoy is remotely released. The design lifetime for the system is 20 years. The control cap is designed for a service interval of five years. Several similar systems are also in production in the North Sea and off Brazil. In fact, several wells have been drilled off Brazil and are awaiting such systems in up to 914 m (3,000 ft) of water.

In October 1974, Exxon installed a subsea production system 27 miles southeast of Grand Isle, Louisiana, in 52 m (171 ft) of water. The system was installed, controlled, and operated remotely utilizing equipment and diverless techniques suitable for producing oil and gas in water depths of approximately 600 m (1,969 ft). A major component of the system is called a maintenance manipulator. When needed, this robot can be lowered to the template and moved around the unit on a track. The manipulator has a system of underwater television cameras built in so the operator on the surface can control its movements. Initial production began in February 1977. A similar system is planned for Exxon's Zinc prospect in 457 m (1500 ft) of water in the Mississippi Canyon Area of the Gulf of Mexico.

Research has also led to the development of several other successful designs of diverless, remotely-operated vehicles (ROV's) now in use worldwide to service subsea wells.

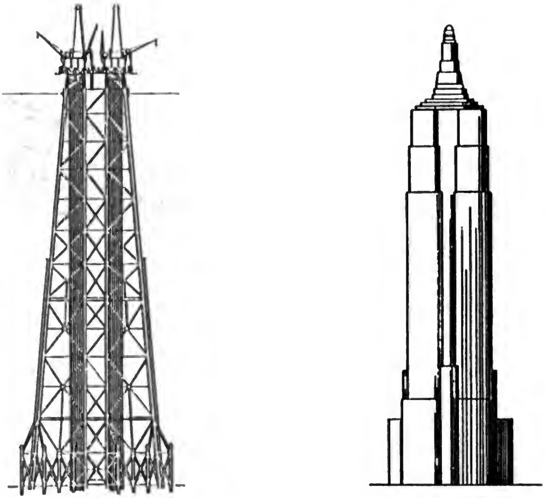
Of the 334 subsea completions worldwide, some 250 are still active. Of those abandoned, only about 5% were abandoned due to downhole or mechanical problems. Most (54%) were abandoned due to reservoir depletion (Hanson, 1985).

If a subsea completion is not used for deepwater production, then some type of platform is necessary at the site. In shallow waters, conventional platforms have become the industry standard for production. From these platforms, a number of wells are typically drilled, and the wellhead completions are on the platform and not on the seafloor. The maximum depth to date for the installation of a conventional platform is 312 m (1,024 ft) by Shell Oil Company's 46,000 ton Cognac platform, 24 km (38 mi) south of the mouth of the Mississippi River (Figure F-8). The platform stands 386 m (1,266 ft) above the seafloor and 73 m (240 ft) above the surface of the ocean. It has slots for a record 62 wells. The base section was installed during the summer and fall of 1977; the other two sections were installed in the summer of 1978. Initial production began in late 1979.

Two other record-breaking conventional platforms are being constructed for installation in 1987 in the Gulf of Mexico. Sohio is constructing a platform for installation in Mississippi Canyon Block 109 in 331 m (1,086 ft) of water, and Shell Oil's "Bullwinkle" platform is to be installed in Green Canyon Block 65 in 411 m (1,350 ft) of water. The Bullwinkle Platform will be the deepest installation to date for a conventional platform. Maximum feasible depth for installation of a conventional platform is about 475-610 m (1,500-2,000 ft) of water.

As production systems move into deeper water, the amount of steel required and thus the cost, increased exponentially. Therefore, other production systems have been developed which cut down on the construction costs (Figure F-9). Exxon designed a guyed tower for 305 m (1,000 ft) water depths (Figure F-10). This structure is bottom-supported with buoyancy tanks in the tower to increase stability and reduce vertical loads, and is held upright by 16 guys, four at each corner. Moorings are designed for the life of the structure (a minimum of 20 years). The deck of the structure is able to move up to 40% of the wave displacement (2-3 m (7-10 ft)) in a storm. The main structural support requires much less steel than a conventional platform.

Using the knowledge and experience gained from a scale model, Exxon installed a fully operational guyed tower to develop their Lena prospect in Mississippi Canyon Blocks 280, 281, 324, and 325. The platform was installed in approximately 300 m (984 ft) of water on Block 280. The design allows for simultaneous drilling and production using 2 rigs, 58 conductors and facilities for producing 25,000 b/d of oil, 5,000 b/d of condensate, and 50 MMcfd of gas. The 20 guyline array employs 5" lines attached to 200-ton articulated clump weights attached by a 5" anchor line to an anchor pile. The maximum tilt of the tower is estimated at 2° with a maximum deck offset of 41 ft (Oil and Gas Journal, 1984). The guyed tower design can be used in water as deep as 610-762 m (2,000-2,500 ft).



Cognac Platform
1265'

Empire State Building
1250'

Source: Shell Oil Co.

Figure F-8. Cognac Platform, Offshore Louisiana

DESIGN, FABRICATION AND INSTALLATION COST VERSUS WATER DEPTH*

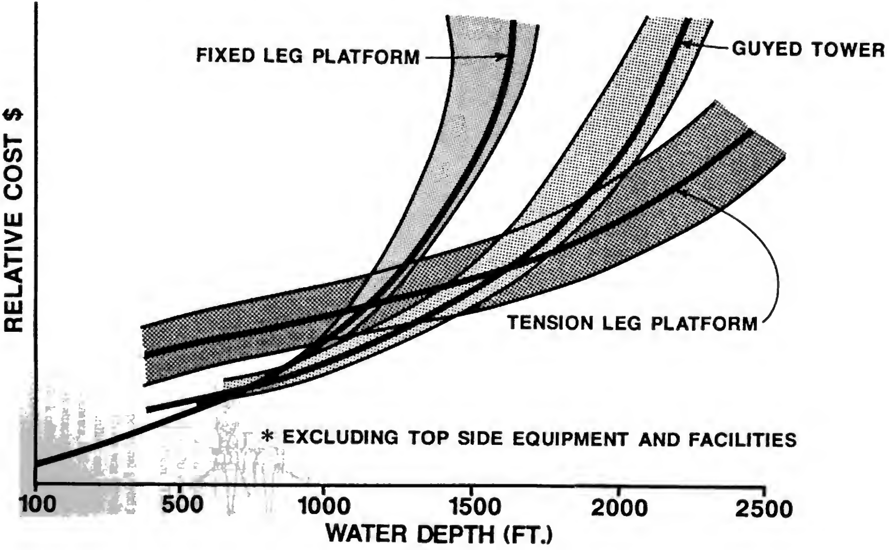


Figure F-9.

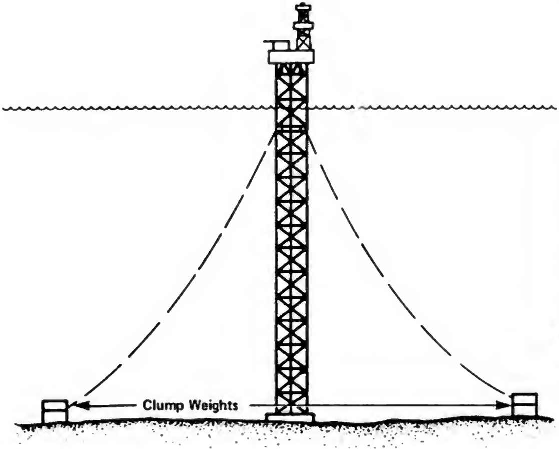


Figure F-10. Guyed Tower

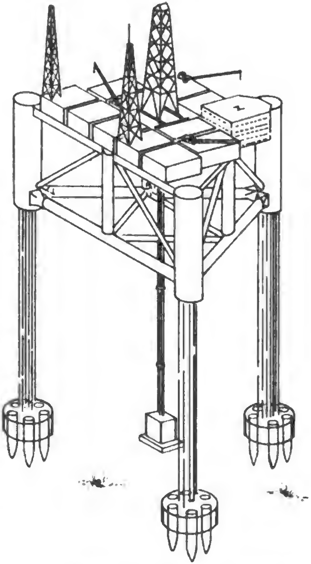


Figure F-11. Tension-Leg Platform

DESIGN, FABRICATION AND INSTALLATION COST VERSUS WATER DEPTH *

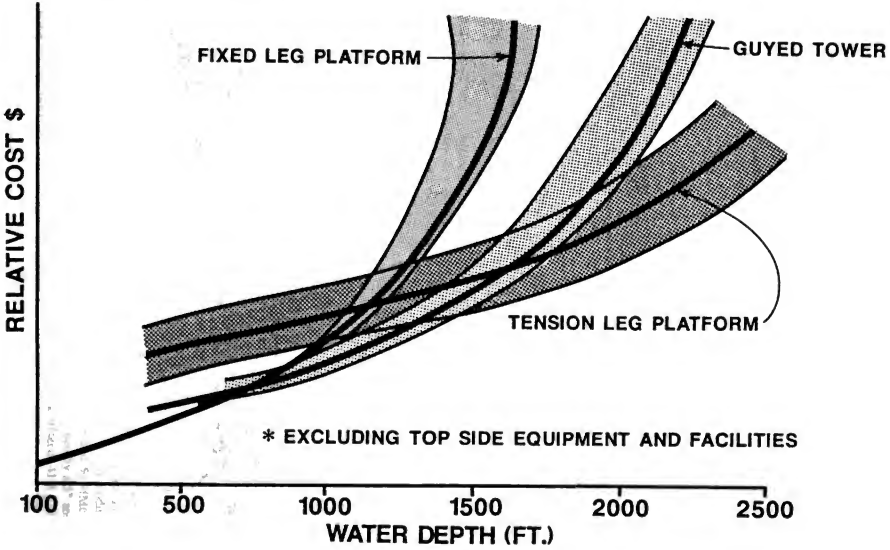


Figure F-9.

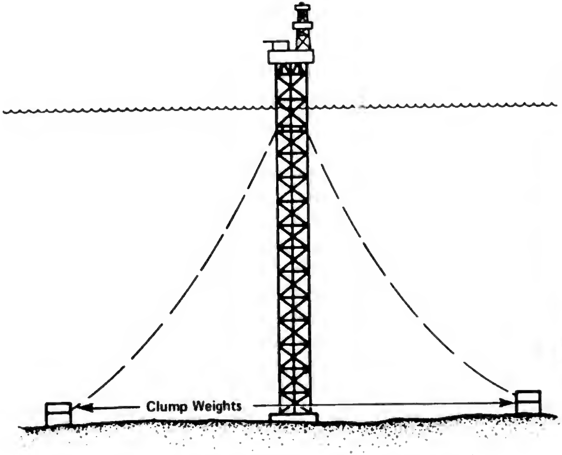


Figure F-10. Guyed Tower

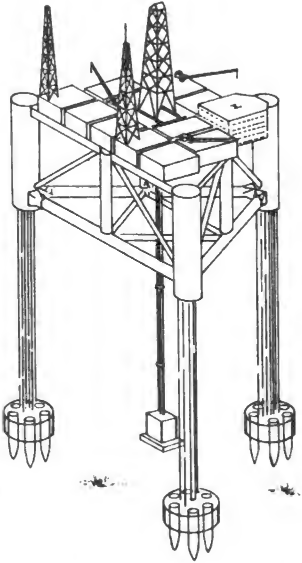
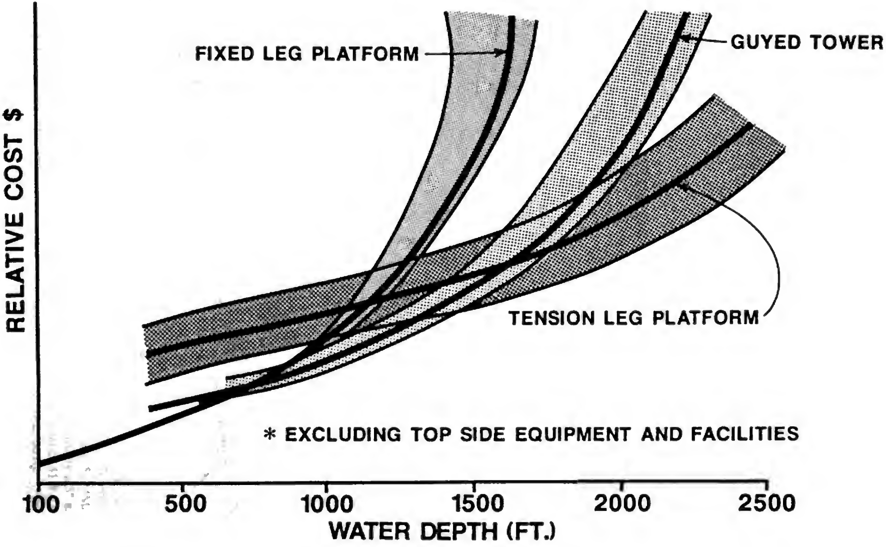


Figure F-11. Tension-Leg Platform

DESIGN, FABRICATION AND INSTALLATION COST VERSUS WATER DEPTH *



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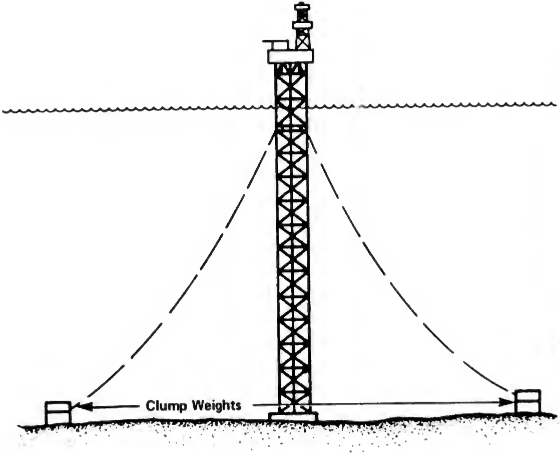


Figure F-10. Guyed Tower

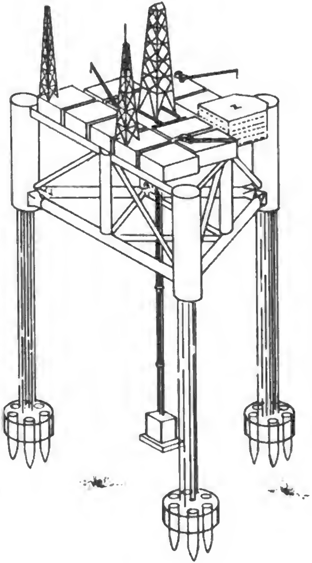
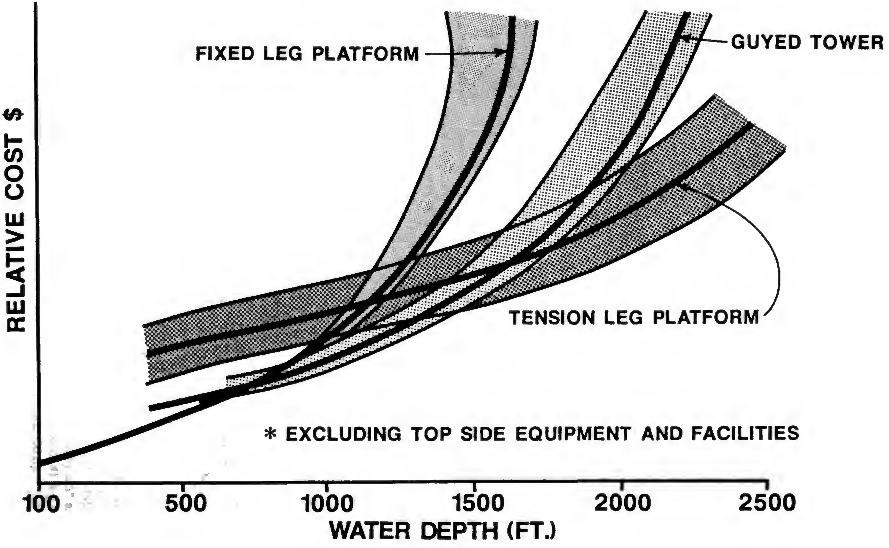


Figure F-11. Tension-Leg Platform

DESIGN, FABRICATION AND INSTALLATION COST VERSUS WATER DEPTH *



* EXCLUDING TOP SIDE EQUIPMENT AND FACILITIES

Figure F-9.

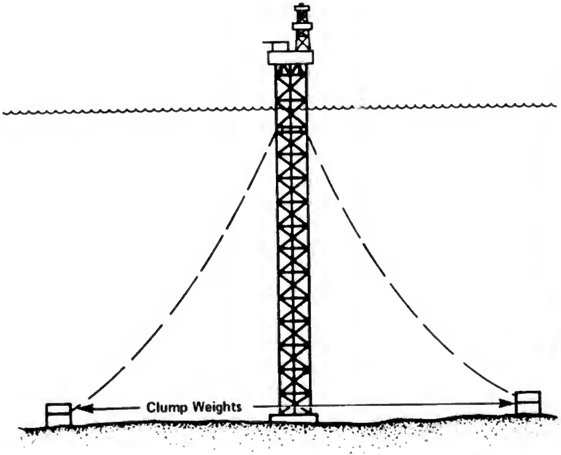


Figure F-10. Guyed Tower

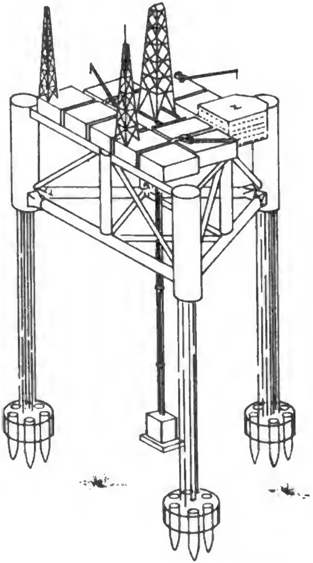
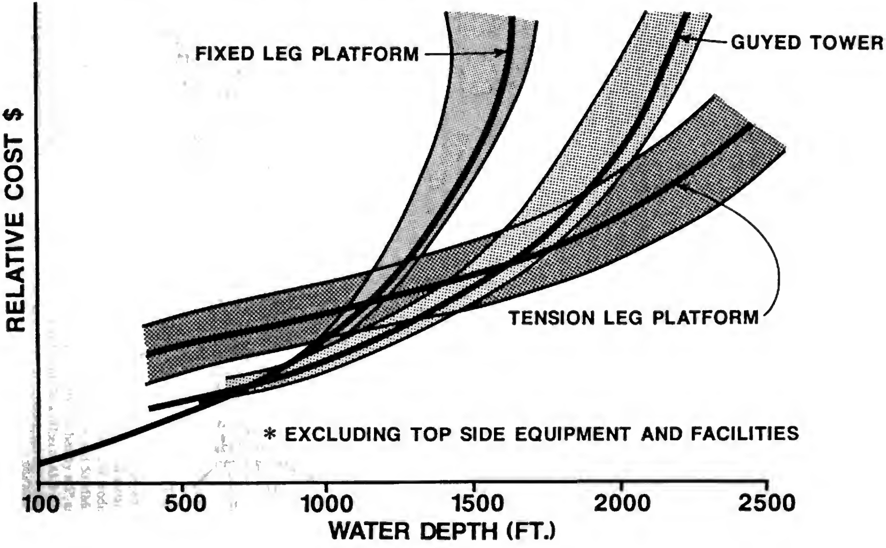


Figure F-11. Tension-Leg Platform

DESIGN, FABRICATION AND INSTALLATION COST VERSUS WATER DEPTH*



* EXCLUDING TOP SIDE EQUIPMENT AND FACILITIES

Figure F-9.

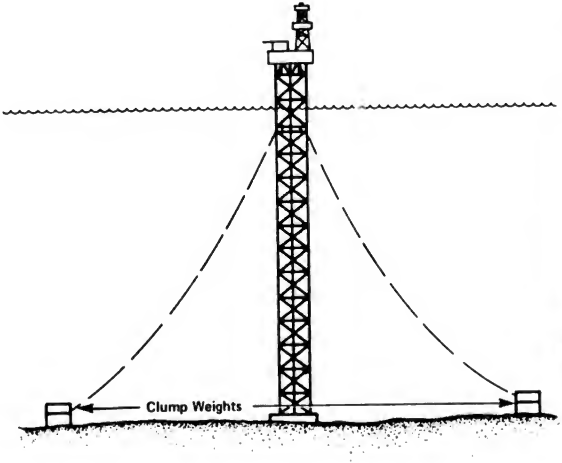


Figure F-10. Guyed Tower

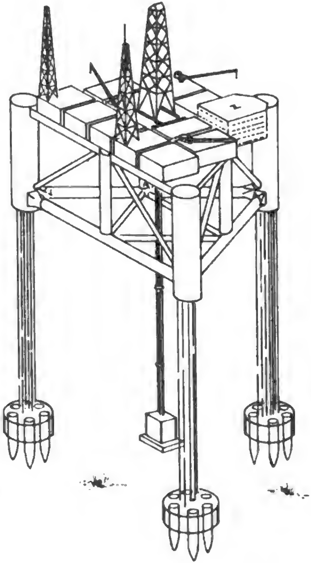


Figure F-11. Tension-Leg Platform

Another concept in production facilities for deepwater is the tension leg platform (TLP) (Figure F-11). The TLP is a floating structure which is held down by essentially vertical tension members which remain in tension regardless of cyclic loads due to current, wind, and waves. This design is also a compliant structure; it is able to move with waves and currents to some extent.

Conoco installed a TLP production system in 151 m (495 ft) of water in the Hutton Field some 95 miles northeast of the Shetland Islands in 1984. The structure is a six leg semi-submersible design which uses anchor piles to anchor the tension members. Tension members are 9-inch diameter rods with a 3-inch hole in the middle; there are four tension members on each corner and each has about 1,000 tons of tension on it. The system is designed so that tension members can be retracted one at a time into the legs for maintenance. The platform has 48 well slots: 24 for initial development, 13 for production, and 11 for water injection (Offshore, 1983c).

Conoco proposes to install a TLP in the Gulf of Mexico (Green Canyon Block 184) in 521 m (1,710 ft) of water. The 24-slot TLP project calls for installation of only the wellheads, test system, workover rig, and possibly a gas compression system on the platform itself. Oil production will be piped to processing equipment on a nearby platform in shallower water. Final installation is slated for mid-1988.

The advantages of a TLP are as follows:

- much less material required for construction than a conventional platform
- the vessel can be fabricated and joined in the yard
- deck and hull are constructed separately and concurrently (at different yards if necessary)
- all the major lifting is done onshore avoiding the extremely high cost of derrick barges
- foundation (template) can be installed separately
- weather sensitive periods for installation are much shorter
- wells can be predrilled
- shorter time between installation and production
- lower abandonment costs
- TLP is reusable; cost can be amortized for several fields

Semi-submersible drill rigs have also been used as floating production platforms. In June 1975, the Hamilton Brothers first produced oil from their Argyll Field in the United Kingdom sector of the North Sea using the converted semi-submersible TRANSWORLD 58 connected to a seafloor manifold and anchor base by a composite riser. Six satellite subsea-completed wells produce to the subsea manifold in 79 m (259 ft) of water. After on-board processing, the gas was flared and crude was pumped back down the composite riser and to a single buoy mooring system nearby for shipment by tanker. The composite riser was vessel-supported and consisted of a central structural riser surrounded by a number of smaller independent satellite risers. The central riser, which in this case carried the low pressure crude to the seafloor and then to a single point mooring for shipment, was designed to withstand the axial and flexural stresses generated by tension, wave action, vessel offset, and current. This structural riser would also receive the buoyancy modules in very deep water. There is little doubt that a vessel-supported composite riser system could be designed to operate in 2,000 m (6,562 ft). A major question, however, is whether th proportion of time that wells would be shutin would be economically acceptable. The avoidance of frequent shutting-in of production during inclement weather would require specialized facilities. There are currently about 18 semi-submersible units worldwide which have been converted to other uses, including 3 for oil production.

Placid Oil is currently designing a floating production platform in conjunction with a subsea production system for their Green Canyon Block 29 Field in 470 m (1,540 ft) of water which many feel will represent the leading edge of technology. Plans call for the conversion of the PENROD 72 semi-submersible, and it will utilize a conventional mooring system. The 1,000-ton subsea production template will have 24 well bays in three rows of seven and will be anchored to the bottom with eight piles. The system will also have remote subsea connection capability for two export pipelines. Top experts in the field are designing the production riser, which will be 84" in diameter and will carry 48 tubing strings and 2 sales pipelines. The design for this system is such that it could be used in water as deep as 1,067 m (3,500 ft).

Although drilling riser technology, subsea completion technology, and floating platform technology have been recently extended to beyond 1,000 m (3,281 ft), production risers, along with remote flowline connectors, represent the critical development component associated with deepwater production systems. The deepest floating production riser system to produce is that of the Enchova Field off Brazil in some 189 m (620 ft). The Enchova production riser system consists of five free-hanging flexible risers: one for combined production to the surface; one export riser to a single buoy mooring; one for annulers access and flow test; and two for water injection. Future plans call for a fixed platform (Gray, 1981).

Another concept for improving production efficiency and re-entry in water depths greater than 365 m (1,197 ft) is the free-standing composite riser (Figure F-12). This system consists of a composite riser fitted with a buoyancy element to provide necessary support to the riser in the disconnect mode, and a remote connect/disconnect stab located at a depth of approximately 100 m (328 ft) in order to put it below the wave action but still within reach of divers. Guidelines from the buoyancy element at the top of the riser to the surface vessel would facilitate a diverless connection. This is similar to the riser system Placid will use as previously described.

Another riser system which offers an extremely bright outlook for future deepwater production is the articulate riser system used for Exxon's Submerged Production System (SPS) (Figure F-13). This riser, along with the system, underwent tests beginning in 1975 in the Gulf of Mexico. The system consists of a base on the seafloor to which all the flowlines run. The lower 300 m (984 ft) for a system designed to 500 m (1,640 ft) consists of a tension member which also provides a housing for the flowlines and which is supported by a buoyancy element. Unlike the free-standing composite riser, there is no provision for an emergency disconnect at the buoyancy chamber level. The SPS riser is designed to withstand maximum sea states and currents and remain connected. The upper 200 m (656 ft) consists of two 100+ m (328+ ft) long sections joined in the middle and at each end by articulate joints. At the surface, the articulate joint is attached to a surface mooring buoy with a permanent yoke attached to a production vessel, probably a converted tanker. The surface mooring buoy locates and supports the upper end of the riser. Each segment has adjustable buoyancy to provide the desired support. Exxon feels that this system would be operable in depths to 1,000 m (3,281 ft).

TRANSPORTATION

When production from deepwater completions is realized, a means of transporting that production to shore must be provided. Two choices are available: (1) hydrocarbons may be piped to the surface and transported by tankers to land-based facilities or (2) they may be transmitted by pipelines all the way. Industry pipeline capability is shown in Figure F-14.

The construction firm of ETPM has developed a method for laying pipe up to 42" in diameter in 1,000 m (3,281 ft) of water. This method is called RAT for Remorgauge (towing), Aboutage (connecting), and Tension. Strings of pipe up to 1,000 m (3,281 ft) long are assembled on shore and fitted with buoyancy tanks. The strings are then towed to the laying site and connected by passing over a special dynamically positioned lay barge; they are then laid in a conventional manner. The method has been tested in the North Sea laying 42" pipe in 250 m (820 ft) of water.

Several other methods are used in deepwater which are quite similar: surface tow, below surface tow, and bottom tow. In each case, the pipeline is made up onshore and towed to the site, where it is connected by a conventional lay barge. Sections of pipe up to 30 km (19 miles) long can be assembled and towed to the site using one of these methods.

All the methods discussed so far have used conventional technology. Conventional pipelaying technology utilizes tensioners to maintain tension on the pipe to keep the sag-bend radius and over-bend radius within acceptable limits (to keep the pipe from buckling) (Figure F-15). The limiting factor in conventional pipelaying techniques is the capacity of the tensioning system.

Another method of laying pipe which has proved very successful is the reel method. This method is less weather dependent than the conventional method and has been in use for many years. Santa Fe Engineering and Construction Company has constructed the first dynamically positioned reel-type pipelaying ship, APACHE. The pipe is welded together on shore, spooled onto a large reel, and rolled off at the site. The APACHE is able to hold up to 81.3 km (50.5 miles) of 4-inch pipe, 9.2 km (5.7 miles) of 16-inch pipe, or various sizes in between. It is able to lay 16-inch pipe in water depths around 610 m (2,000 ft) and smaller lines in water depths of 915 m (3,000 ft). With smaller portable reels, it can lay a bundle of several pipes at one time. Using this method, a 12-inch pipeline has been successfully installed in the Gulf of Mexico in more than 300 m (984 ft) of water.

Saipem's CASTORO SEI is a semi-submersible pipelaying barge which laid three 20-inch pipelines from Tunisia to Sicily across the Mediterranean Sea. Water depths of up to 600 m (1,968 ft) were encountered. The production rate averaged 1.5 km per day and went as high as 2.5 km per day. The CASTORO SEI was able to continue work in seas up to 6 m (20 ft), and the limiting factor for the vessel to continue operating was the weather limitations of the anchor handling tugs. With this experience under their belt, Saipem is now testing the depth

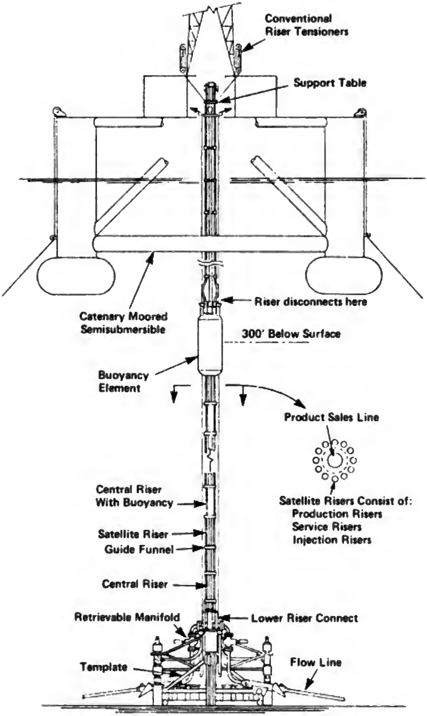


Figure F-12. Free-Standing Riser

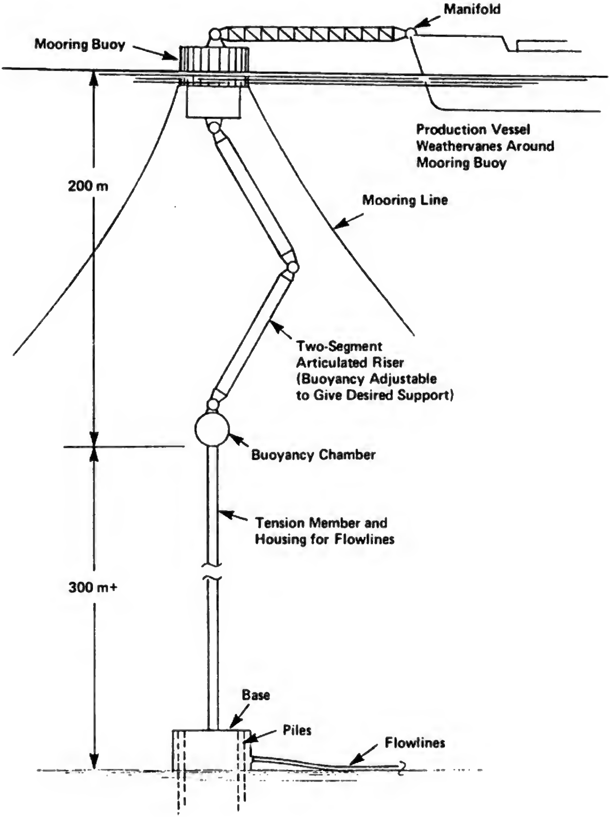

Manifold
Mooring Buoy
Production Vessel Weathervanes Around Mooring Buoy
200 m
Mooring Line
Two-Segment Articulated Riser (Buoyancy Adjustable to Give Desired Support)
Buoyancy Chamber
Tension Member and Housing for Flowlines
300 m+
Base
Piles
Flowlines

Figure F-13. Exxon Articulated Riser

INDUSTRY PIPELINE CAPABILITY PROJECTION

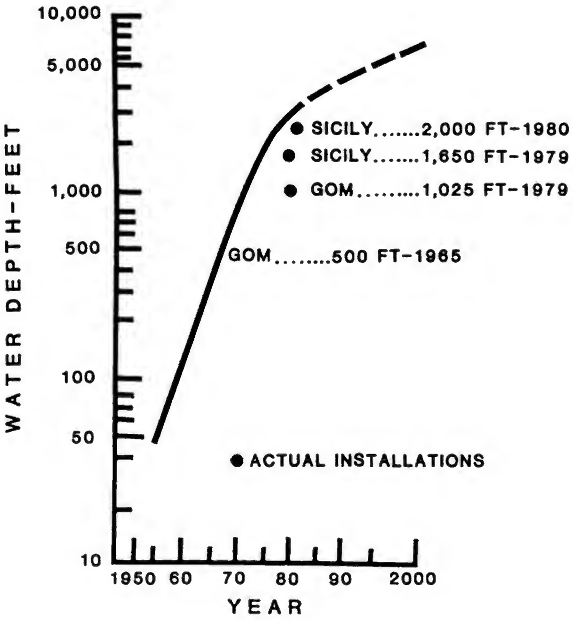


Figure F-14.

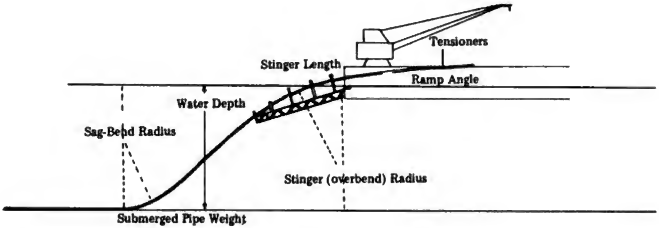


Figure F-15. Conventional Pipelaying

capability of the CASTORO SEI at 1,200 m (3,937 ft), and even this may not be the limit of the system. Officials with Saipem feel that the vessel can lay pipe in water depths up to 2,100 m (6,890 ft) (Petroleum Engineer International, 1980).

To alleviate the sag-bend and over-bend problems mentioned previously, an inclined ramp concept has been designed. This would partially eliminate the upper part of the "S-curve." Once again, tensioners are the limiting factor. To completely eliminate the over-bend, a method ("J-bend") has been devised to lay pipe vertically (Figure F-16). Conventional drilling rigs could be used to lower the pipe to the seafloor. The disadvantages of the system are that only one section of pipe could be welded at a time rather than the multistation welding used in conventional pipelaying and some sort of vertical tensioning device, such as those used in drilling would have to be devised instead of the conventional friction pads. Research is underway on electron beam welding to help speed up the J-bend process.

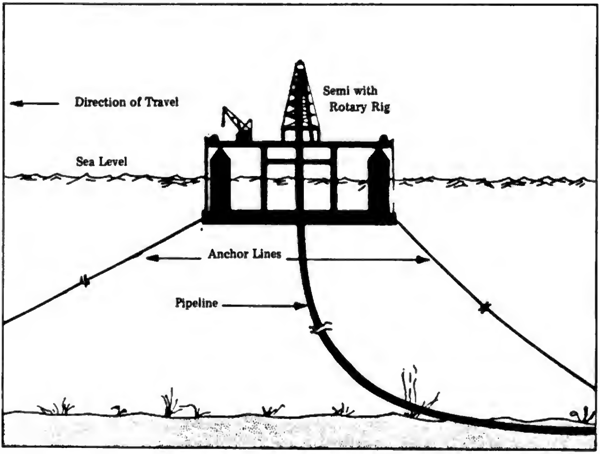
SUMMARY AND CONCLUSION

The industry presently has the capability to drill in water depths to about 2,440 m (8,005 ft). Research is currently being conducted by several major oil companies, and projections from such research are that within five years, technology will permit drilling in water depths to 3,000 m (9,842 ft). The deepest exploratory well for oil or gas was drilled in 2,119 m (6,952 ft) of water. The deepest discovery to date is in 671 m (2,201 ft) of water off Spain but was of insufficient quantity to justify development. The deepest commercial wellhead completion is a well completion in 388 m (1,273 ft) off Brazil. The deepest dry tree subsea completion is in 120 m (394 ft) in the Garoupa Field, Brazil (Offshore, 1981). A general consensus in the oil industry, however, is that they can presently produce in up to 1,067 (3,500 ft) of water and that within 10 years they will have the technology to produce in over 1,800 m (5,095 ft) of water.

The deepest pipeline was laid between Tunisia and Sicily in 610 m (2,000 ft) of water. The "J" laying technique coupled with electron beam welding makes it possible to lay pipe up to 40" in diameter in water as deep as 3,000 m (9,842 ft) in a single run for a dynamically positioned superbarge.

Oil and gas operations in ever greater water depths require the use of new and more economical production systems. Subsea completion technology is being tested in shallow depths to provide procedures to be used in very deep water. All industry experts agree that, if given the necessary economic incentives, the technology will be available. A secondary result of subsea completion technology is the ability to develop small reservoirs without the expenditures required for a surface structure. As the price of oil increases on the world market, the feasibility to utilize more sophisticated production systems will be realized. At present, operations in deepwater have understandably slowed with the low world price of oil.

The capability for deepwater drilling has been in existence for several years and, in fact, a surplus of that capability is expected to continue for several more years. The deep wells drilled in the next several years will probably be drilled by a dozen major oil companies in order to meet lease or concession obligations. Production riser technology is the limiting factor in the ability to exploit reserves of hydrocarbon occurring in deepwater. Before that exploitation can take place, the price of oil will have to increase significantly in order to make it economically feasible.



Source: OFFSHORE Magazine

Figure F-16. Vertically-laid Pipeline in Deepwater

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Appendix G

Oceanography Figures Referenced in Section III*

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* These figures were compiled from information on this topic that was recently received, causing a major revision in the text of Section III.A.3. The visuals with the corresponding new figures could not be printed for the Draft EIS; therefore, the figures will be included in this Appendix. However, they will be shown on the new visual printed and distributed with the Final EIS and will be referenced as such.

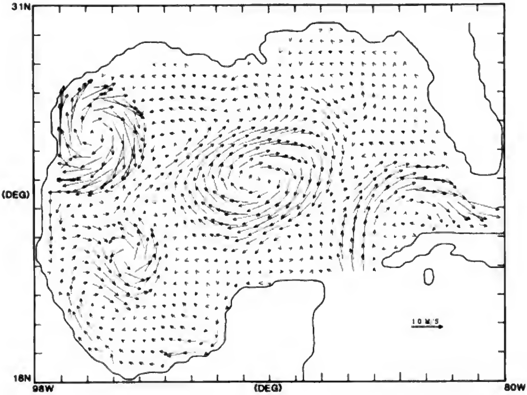

Figure G-1. Circulation Stages E1/W4. NORDA/Jaycor model simulation of surface currents for model day 3978 and wind day 1967:359 from a 10-year simulation (Wallcraft, 1985).

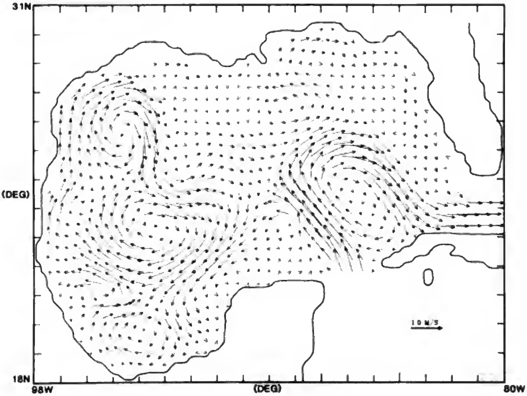

Figure G-2. Circulation Stages E2/W5. NORDA/Jaycor model simulation of surface currents for model day 4128 and wind day 1968:144 from a 10-year simulation (Wallcraft, 1985).

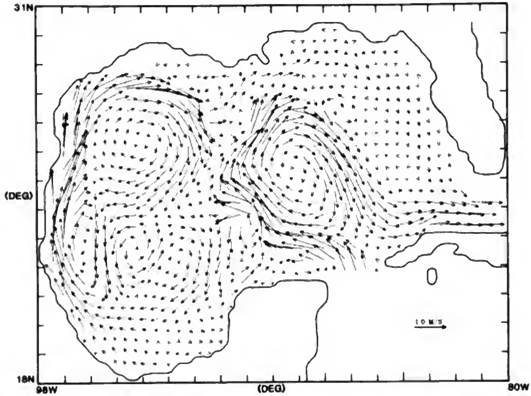

Figure G-3. Circulation Stages E3/W6. NORDA/Jaycor model simulation of surface currents for model day 4218 and wind day 1968:234 from a 10-year simulation (Wallcraft, 1985).

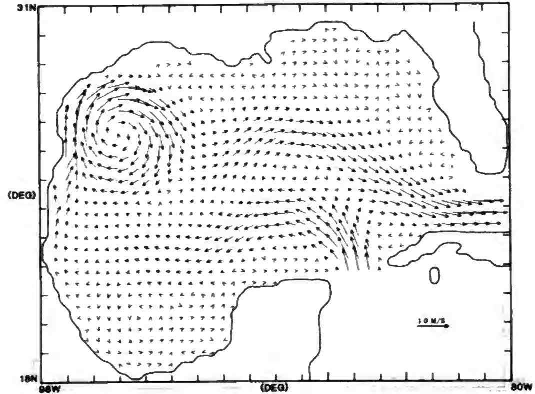

Figure G-4. Mean geostrophic surface currents (m/sec) from a 3-year simulation with the NORDA/Jaycor circulation model (Wallcraft, 1985). The vectors serve to illustrate the significance of surface topographic contours from the three previous figures, due to their general similarity, i.e., clockwise circulation about topographic highs and vice versa (northern hemisphere). No great significance should be given to this and other published long-term mean geostrophic current representations of the Gulf of Mexico due to the dynamic nature of its circulation.

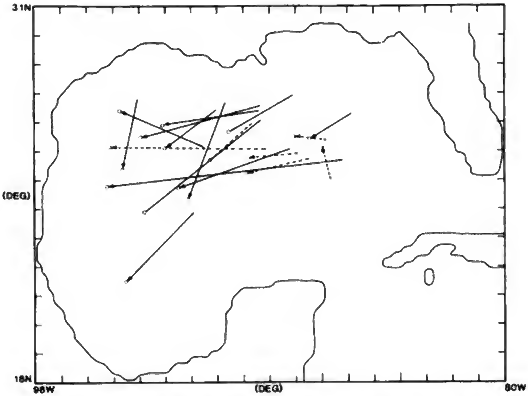

Figure G-5. Composite of eddy paths, indicating initial and final locations for eddies, studied by Elliott using hydrographic data from 1965-1972 (Elliott, 1982) (triangles) and by Brooks et al. (1984) (circles) using satellite imagery from 1980-1984.

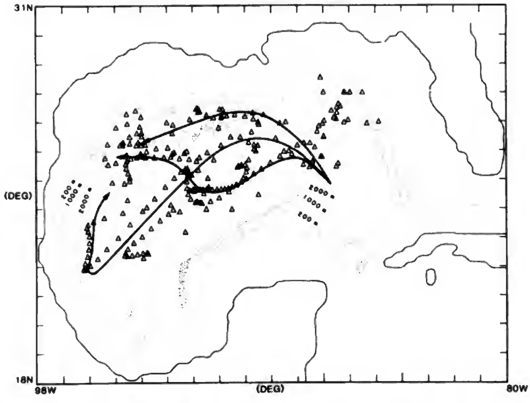

Figure G-6. Composite of all anticyclonic eddy locations identified by Vukovich (1985) in a study of 10 years of remote imagery (1974-1984). Three preferred paths were identified, indicated by the solid arrows. Bathymetry is included here to point out a possible depth limitation for these features.

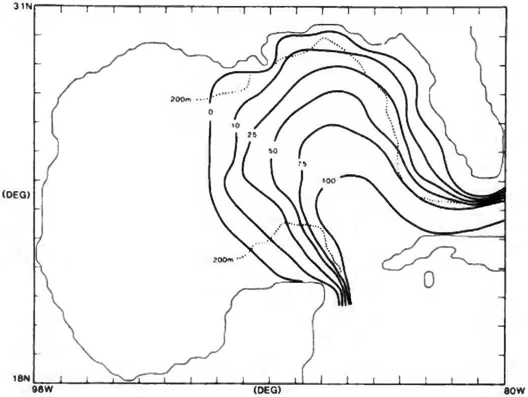

Figure G-7. Frequency of occurrence (%) for Loop Current water during March for the period 1973-1977, analyzed for unit 1° latitude-longitude squares based on satellite data (Vukovich et al., 1978). Of the seven months similarly analyzed (few satellites observations are useful from June to October), March displayed the apparent greatest intrusion, while November displayed the least.

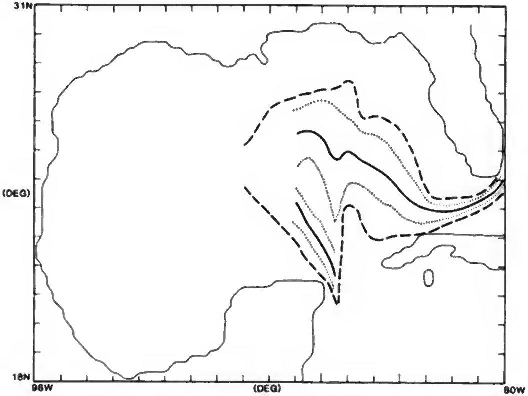

Figure G-8. Wave-staff analysis of the Loop Current boundary showing the mean location (solid line), northernmost and southernmost observed locations (dashed lines), and standard deviation of the mean location (dotted line) for the period May 1981-May 1982 (Auer, 1983).

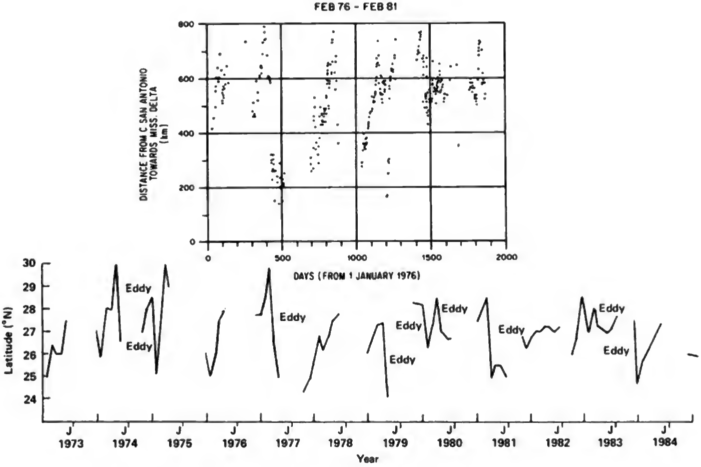

Figure G-9. Revisions and extensions of two analyses previously published by Maul et al. (1978) and Vukovich et al. (1978) (upper and lower, respectively). Maul (personal communication, 1985) analyzes Loop Current penetration into the Gulf of Mexico along a line from Cape San Antonio, Cuba, to the Mississippi Delta. Vukovich (personal communication, 1985) measures northern extension by latitude and also notes specific eddy-shedding events. The graphs, approximately registered here along the time axis, reflect cycles which are neither regular nor annual. As a point of comparison, the NORDA/Jaycor model sheds 13 eddies in a 10-year simulation (Wallcraft, 1985), agreeing well with these results.

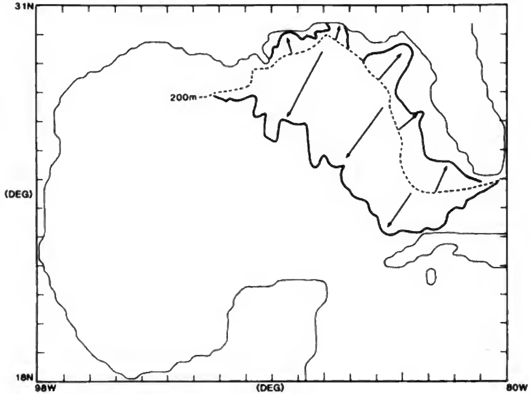

Figure G-10. The Loop Current boundary is frequently observed to include warm intrusions onto the shelf (shoreward of 200 m) and cold intrusions extending from the shelf seaward of 200 m. Vukovich et al. (1978) provide these analyses showing the integrated effect of all warm intrusions and cold intrusions from the months of January through May and November and December in 1973-1977. Arrows indicate the general sense of movement but are not drawn to portray specific events.

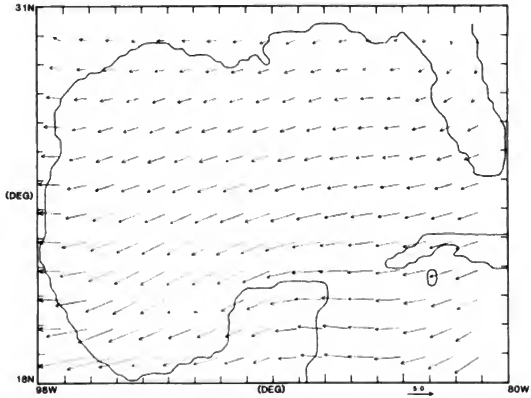

Figure G-11. Winter (December-February) geostrophic winds (m/sec) averaged for the period 1967-1982 (Rhodes et al., 1985).

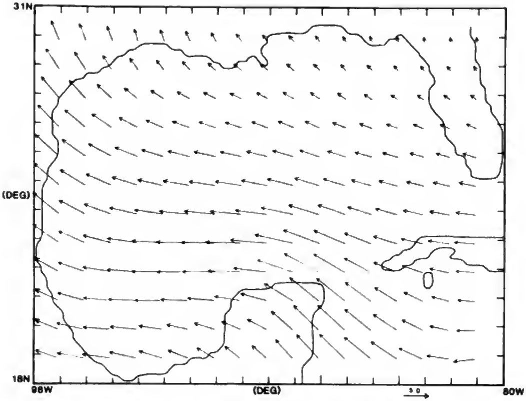

Figure G-12. Spring (March-May) geostrophic winds (m/sec) averaged for the period 1967-1982 (Rhodes et al., 1985).

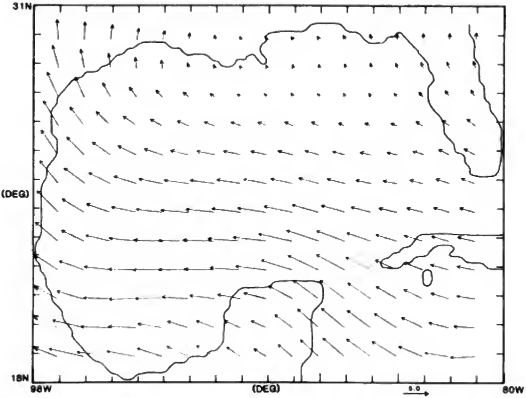

Figure G-13. Summer (June-August) geostrophic winds (m/sec) averaged for the period 1967-1982 (Rhodes et al., 1985).

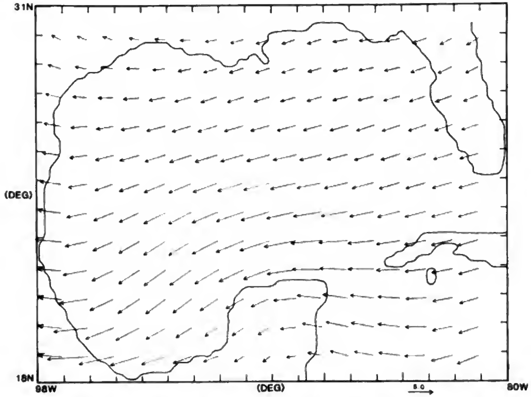

Figure G-14. Fall (September-November) geostrophic winds (m/sec) averaged for the period 1967-1982 (Rhodes et al., 1985).

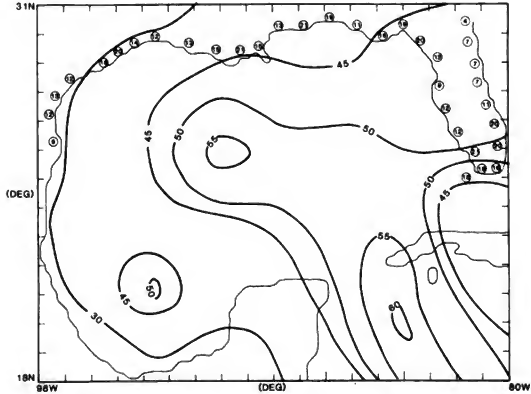

Figure G-15. Percentage probability that at least one tropical storm or hurricane per season will enter a unit 2½° latitude-longitude box (solid isopleths), modified after Hope and Newmann (1971) with some reduction in detail. Percentage probability that a tropical storm or hurricane will occur in any one year in a 50-mile segment of the coastline (circles) adopted from Simpson and Lawrence (1971). Consult the original source for precise segment locations, modified here for clarity. The lower limit for wind speeds which define a tropical storm is 34 knots.

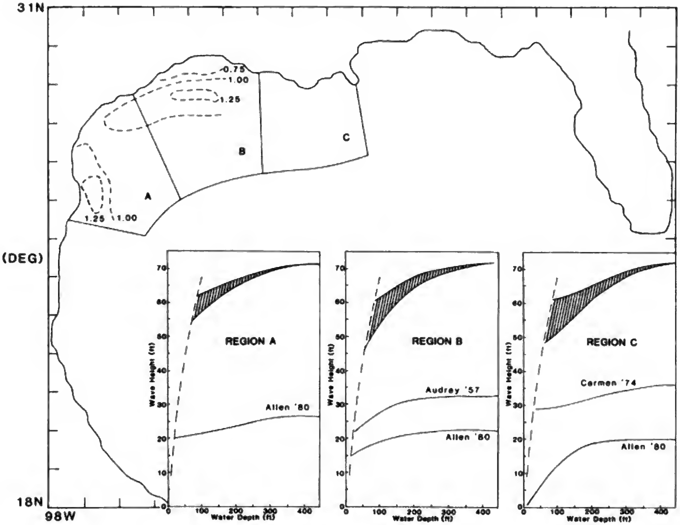

Figure G-16. Hindcast 100-year expected maximum wave heights (upper envelope) and hindcast significant wave heights for selected hurricanes (lower curves), modified from Bea et al. (1983). The dashed line on the left side of each graph is the breaking limit. The dashed contours on the map key represent the 100-year significant wave height, normalized by dividing by the average 100-year value, over Region A and much of Region B (after Resio and Berek, 1985), indicating regional variability.

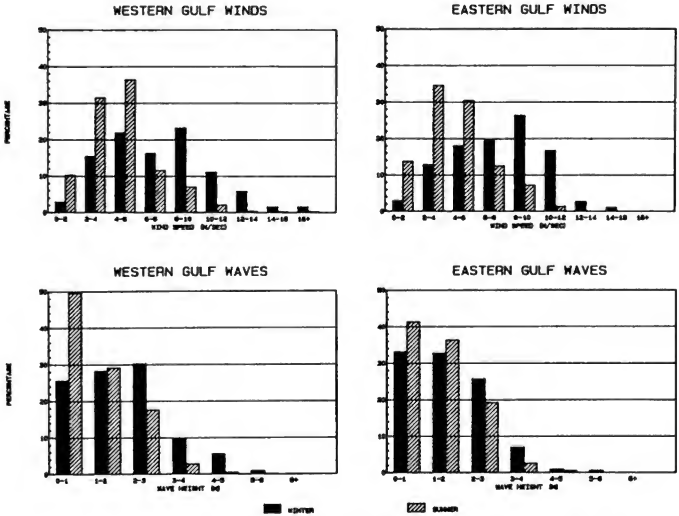

Figure G-17. Distribution of wind speed (upper graphs) and significant wave height (lower graphs) for the Western and Eastern Gulf of Mexico, winter and summer, from all GEOS-3 altimeter data (Parra et al., 1981).

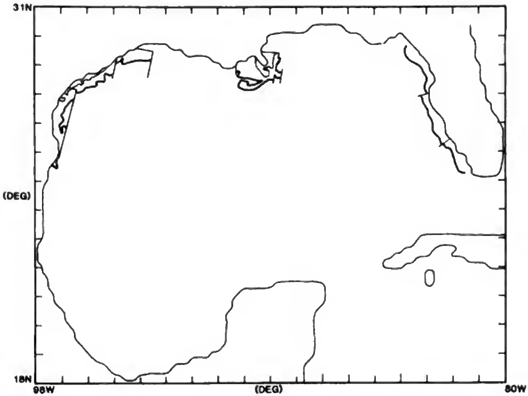

Figure G-18. Offshore Texas: Integration of several landsat imagery interpretations of a turbid coastal front (Shideler, 1979), shown here as the maximum (solid line) and minimum (dotted line) offshore penetration. Offshore Louisiana: Similar presentation for quantitative landsat interpretations by Rouse and Coleman (1976). Offshore Florida: Location of a marked "front" (solid line) in the irradiance attenuation coefficient, decreasing in the offshore direction, after Van Norden and Litts (1979). In all three areas, straight lines indicate the limits of satellite images used (Texas and Louisiana) or the limits of seasonal data available (Florida).

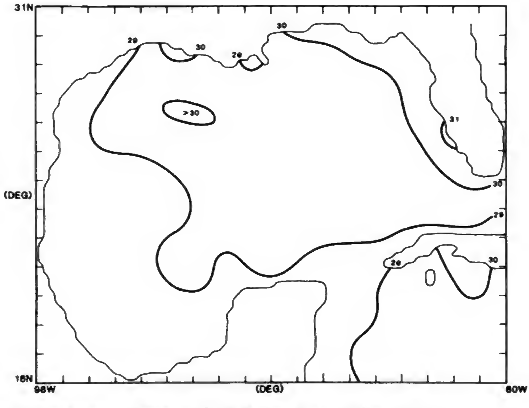

Figure G-19. Average sea-surface temperature (°C) for the month of August (Robinson, 1973).

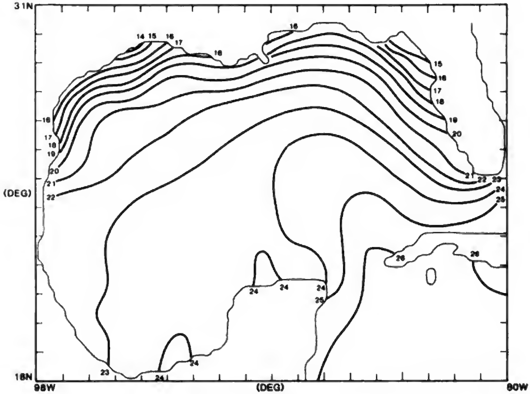

Figure G-20. Average sea-surface temperature (°C) for the month of January (Robinson, 1973).

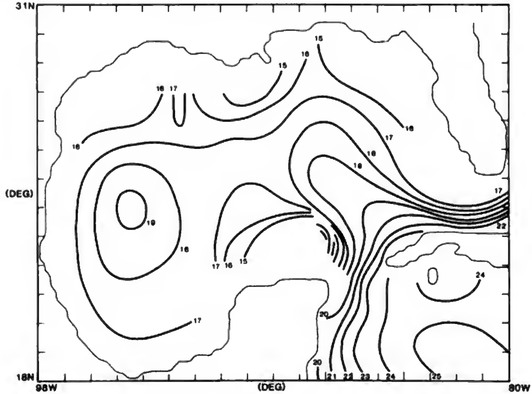

Figure G-21. Average temperature (°C) at 150 meters for the month of January (Robinson, 1973).

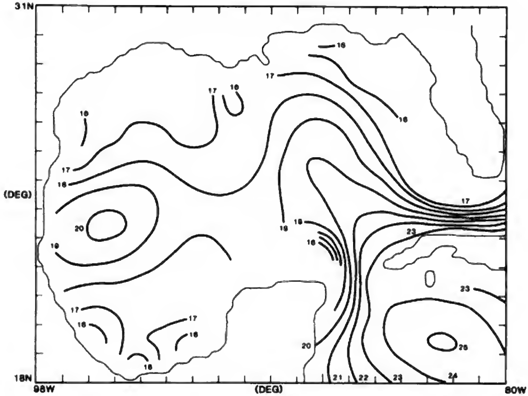

Figure G-22. Average temperature (°C) at 150 meters for the month of August (Robinson, 1973).

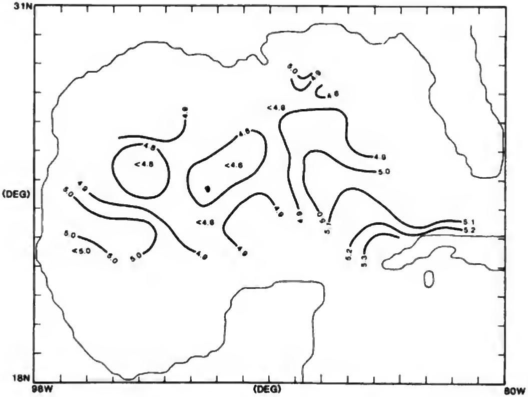

Figure G-23. Annual average temperature (°C) at 1000 meters (Molinari and Festa, 1978).

Appendix H

Comparison of Pipeline and Tanker Transportation System Options for Deepwater Areas in the Gulf of Mexico

I. TRANSPORTATION SYSTEM OPTIONS

The deepwater areas of the Gulf of Mexico are still essentially frontier areas in terms of oil and gas production with no existing transportation systems for crude oil or gas. Transportation systems must be designed and built to deliver hydrocarbon either directly to shore or to existing pipeline systems in shallower water. Several transport systems utilizing pipelines and/or tankers could perform this function. Due to the number of factors involved, industry practice is to select a transportation system on a case-by-case basis after thorough analysis of all relevant factors, such as size and location of the find; final destination of produced hydrocarbons; processing and fluid reinjection requirements at the site; handling and storage facilities needed at intermediate locations along the transportation route; proximity to existing transportation facilities; oceanographic and meteorological conditions of the area; and environmental safety factors. State and local attitudes and coastal zone management policies toward offshore development, production, and transportation in a given area are considered.

Economic considerations are foremost in the industry decision on which transportation system to utilize for produced hydrocarbons. The size of the find, production costs, and market price of oil and gas are important in the consideration of the feasibility of production and what type of transportation system will be used.

Two transportation systems or modes will be considered in the comparative analysis which follows: (a) pipeline from the site to existing pipeline facilities in shallow water; and (b) production from a subsea completion or floating platform to an auxiliary floating production, storage, and offloading system (comprised of a modified tanker and a single point mooring system) with shuttle tankering to shore.

A. PIPELINE MODE

Production would occur through the use of a bottom-supported or floating platform and would be piped either directly to shore or to production and processing equipment at a facility in shallower water and then to shore. Conventional platforms have long been the standard for oil and gas production in shallow water. Production and processing equipment is located on the platform, and hydrocarbons are then piped directly from the platform to shore or to existing pipeline systems in shallower water. Other bottom-supported platform designs, such as the guyed tower, and floating designs, such as the tension leg platform, would function in a similar manner.

In order to extend the water depth capability, down-sized floating platforms may be used, in which case production would be piped through flow lines to processing equipment permanently located nearby in shallower water (this could include a permanently moored modified tanker similar to the one used for the tanker mode); oil would then be moved by pipeline either directly to shore or to an existing main pipeline and then to shore.

B. TANKER MODE

Oil is pumped from either a subsea completion or floating downsized platform to a floating production, storage, and offloading system (consisting of a large modified tanker permanently attached to a single-point mooring system) containing the necessary production and processing equipment. The oil is then transferred to tankers for shuttling to shore.

II. COMPARATIVE ANALYSIS OF TANKERING VERSUS PIPELINING

The potential impact causing factors and related impact causing events associated with the use of tankers (hereinafter referred to as shuttle tankers) and pipelines to transport crude oil from a representative hypothetical deepwater production area to shore are described and compared in this analysis.

A. ASSUMPTIONS USED IN THE ANALYSIS

1. The location of the hypothetical production area is as shown on Figure H-1.

2. 100 million bbls of oil would be produced and transported.

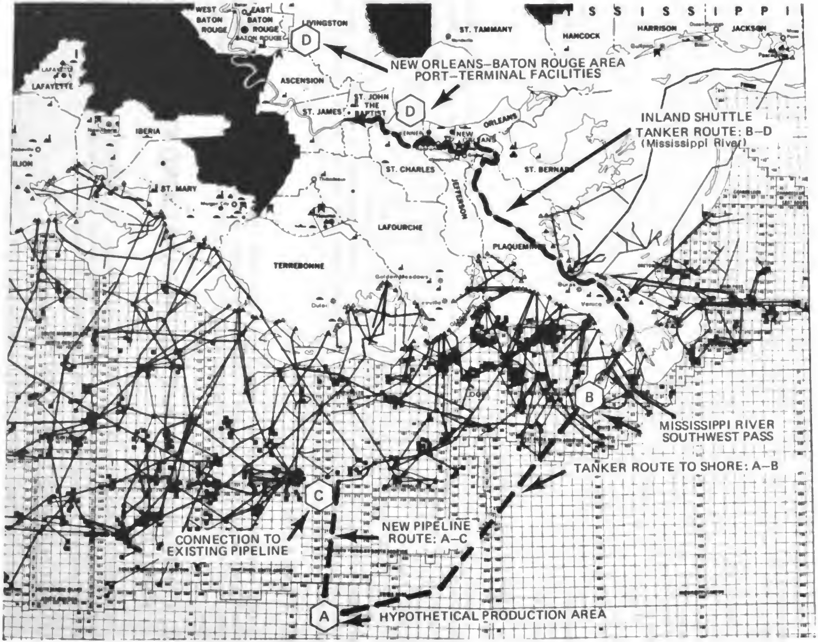

Figure H–1. Comparative Analysis of Tankering and Pipelining: Hypothetical Production Area, Tanker and Pipeline Routes

3. Production will take place over a 15-year period: 1993-2008.

4. Average annual production of 6.67 million bbls and peak annual production of 12 million bbls.

5. Shuttle tanker transportation mode parameters:

   a. Use of 20,000 dwt tankers.

   b. A total of 739 trips would be made over the 15-year production period.

   c. The maximum number of annual trips would be 89, occurring in 1996.

   d. The average annual number of trips would be 50.

   e. Tanker route as shown on Figure H-1.

6. Existing port/terminal facilities in the New Orleans-Baton Rouge area would be used to offload the shuttle tankers.

7. Pipeline transportation mode parameters:

   a. 30-40 miles of new pipeline emplaced.

   b. The new pipeline would connect with an existing main pipeline.

   c. New pipeline route as shown on Figure H-1.

8. Oil spill rate assumptions:

Number of Spill Occurrences per Billion Barrels Produced/Transported

Source	≥ 1,000	≥ 10,000	≥ 100,000	1,000-10,000	10,000-100,000
Platforms	1.0	0.44	0.036	0.56	0.40
Pipelines	1.6	0.66	0.065	0.93	0.62
Tankers	1.3	0.65	0.27	0.65	0.38
At Sea	0.9	0.50	0.19	0.40	0.31
In Port	0.4	0.15	0.08	0.25	0.07
Onloading	0.2	0.075	0.04	0.125	0.035
Offloading	0.2	0.075	0.04	0.125	0.035

The rates for tankers "in port" are assumed to be evenly divided between the offshore product site (onloading facilities) and port/terminal offloading facilities.

9. Oil spill average size (1,000 bbls or greater):

   a. Pipelines: 25,937 bbls
   b. Tankers: 54,750 bbls

10. Operational discharge assumptions:

a. Operational discharge of tank cleaning water and oily ballast water will not exceed 1/15,000 of the deadweight of the shuttle tankers used. For 20,000 dwt shuttle tankers this amounts to 9 bbls per trip.

b. Operational discharge would not occur within 50 miles of land.

c. The rate of operational discharge would not exceed 1.6 liters per mile traveled.

B. ANALYSIS OF IMPACT CAUSING FACTORS AND RELATED EVENTS

The following analysis discusses and compares the impact causing factors and related events for the pipeline and shuttle tanker transportation modes that would be associated with activities related to each option at the production site, along the route to shore, and at the port/terminal facilities. A tabular summary of the major estimated impact causing factors and related events associated with these activities is presented in Table H-1.

1. At Offshore Production Site

There is no difference in the effects of development drilling, platform installation and operation, and installation and operation of auxiliary floating production and storage systems.

Oil Spills (accidental). The major difference between the two transportation modes is that the use of shuttle tankers would require an offloading system as part of the floating production and storage system. The transfer of crude oil from the floating production/storage system to the shuttle tanker routinely occurs. Most spillage is expected to be related to low-volume events (99% of OCS related spills have been less than 50 bbls and of these about 90% have been less than 1 bbl). The numbers of large spills of 1,000 bbls or greater and 10,000 bbls or greater are both 0.0 (0.2 and 0.008, respectively). These fractional numbers indicate that the probability of one or more spills of these magnitudes is very low (about 2% for 1,000 bbls or greater and less than 1% for 10,000 bbls or greater). The combined probability of a large spill occurring and contacting land or an offshore environmental target is estimated at less than 0.5%.

2. Along Route to Shore

Oil Spills (accidental). The estimated number of spill occurrences of 1,000 bbls or greater is fractional for both modes: 0.1 for tankering and 0.2 for pipelining. The probabilities of one or more spills of 1,000-10,000 bbls and of 10,000-100,000 bbls are about 125% and 100% greater, respectively, for pipelining. However, the probability of a 100,000 bbls or greater spill is 2% for tankering compared to 0.6% for pipelining. These statistics indicate that the basic difference between the two modes is that with pipelines there is a significantly greater chance of a large spill occurring; however, should such a spill occur there is a 96% chance that it would be less than 100,000 bbls. Conversely, with tankering there is a significantly lower probability of a large spill occurring; however, should such a spill occur, there is a 21% chance that it would be greater than 100,000 bbls. Historic spill statistics also indicate that the average size of a pipeline spill is about one-half (47%) that for tankers. Thus, an average size tanker spill occurring and subsequently contacting (within about 10 days) a sensitive resource could, because of its larger initial size, affect more (up to twice as much) resources than would an average size pipeline spill.

Using the scenario assumption that 20,000 dwt tankers would be used to shuttle the oil, there would be a worst case possibility that an accident could result in the complete loss of the 135,400-bbl cargo. In comparison, the largest pipeline spill to occur in the Gulf of Mexico since OCS production began in the early 1950's occurred in 1967; the size of the spill was estimated at about 160,000 bbls.

Routine Operational Discharges. Tankering could result in operational discharges (associated with tank cleaning and bilge pumping) of up to 9 bbls for 20,000 dwt tankers per round trip, or an average of about 450 bbls per year over the 15-year production period. (This assumes the use of tankers without segregated ballast systems and the unavailability of suitable onshore reception facilities for oily wastes.) These routine ("legal") discharges are not expected to occur within 50 miles of shore, and the rate of discharge is expected to be 1.6 liters or less per mile traveled. These discharges are very small and are expected to have a minimal effect on the sensitive resources with

1a H-1

Comparison of Tanker and Pipeline Transportation of Oil from Hypothetical Production Site:
Estimated Impact Producing Factors and Events

	At Production Site		Along Route to Shore/Port		At Port Terminal Facilities		Total	
	Tankering	Pipelining	Tankering	Pipelining	Tankering	Pipelining	Tankering	Pipelining
Oil Spills (≥1,000 bbls)								
Occurrences -								
Number[1]/Probability[2]								
≥1,000 bbls	<0.05/2%	-	0.1/9%	0.2/15%	<0.05/2%	-	0.1/12%	0.2/15%
≥10,000 bbls	<0.05/<1%	-	0.1/5%	0.1/6%	<0.05/0.7%	-	0.1/6%	0.1/6%
≥100,000 bbls	<0.05/<0.5%	-	<0.05/2%	<0.05/0.6%	<0.05/<0.5%	-	<0.05/3%	<0.05/0.6%
1,000-10,000 bbls	<0.05/1%	-	<0.05/4%	0.1/9%	<0.05/1%	-	0.1/6%	0.1/9%
10,000-100,000 bbls	<0.05/<0.5%	-	<0.05/3%	0.1/6%	<0.05/<0.5%	-	<0.05/4%	0.1/6%
Barrels of Oil Spilled[3]	1,095	-	4,928	4,150	1,095	-	7,118	4,150
Contacts - Numbers[4]/Probability[5]								
≥1,000 bbls	<0.05/<0.5%	-	<0.05/4%	0.1/6%	<0.05/2%	-	0.1/6%	0.1/8%
≥10,000 bbls	<0.05/<0.5%	-	<0.05/2%	0.0/3%	<0.05/0.7%	-	<0.05/3%	<0.05/3%
Operational Discharges	-	-	9 bbls per trip	None	None	-	9 bbls per trip	None
Facility Construction	-	-	-	30-40 miles of pipeline emplaced	None	-	None	30-40 miles of pipeline emplaced

[1] The mean number of spill occurrences is equal to the volume of oil produced and transported (100 million bbls) multiplied by the spill rates for the source and the spill size category.

[2] The probabilities listed are the percent chance of one or more spill occurrences. Oil spills greater than 1,000 bbls are considered to be governed by a Poisson process (Smith and others, 1982 and Lanfear and Amstutz, 1983). The probability of a specific number of spills (P(n)) occurring is described by the Poisson distribution: $P(n) = e^{-a} a^{n}/n!$, where n is the specific number of spills (0, 1, 2, . . ., n), e is the base of natural logarithms, and a is the mean of the Poisson distribution. The probability of one or more spills is calculated as $1 - P(o)$ or $1 - e^{-a}$, where is is the (mean) number of occurrences.

[3] Number of spills ≥1,000 bbls multiplied by the average spill size.

[4] The mean number of spills occurring and contacting shore (land) within 10 days. The mean number is derived by multiplying the estimated mean number of spill occurrences (footnote 1) by the estimated probability that a spill occurring at a particular location (the production site, along the pipeline and shuttle tanker routes to shore, and at port terminal facilities which includes the inland water route) will contact land within 10 days. The estimated probability of a spill contacting land within 10 days if it occurs in the production site area (which includes the floating production/storage system from which produced oil is transferred to shuttle tankers), and if it occurs along the pipeline and shuttle tanker routes to shore were derived from the oil spill trajectory simulation estimates which are used in the OSRA for GOM OCS lease sale EIS analyses (no oil spill runs were made specifically for this analysis). The probability of a contact from a spill occurrence while inport and enroute in inland waters, is assumed as 1 (the oil spill trajectory simulation is not run for inland water and port areas).

[5] The probabilities listed are the percent chance of one or more oil spills occurring and contacting land within 10 days. These probabilities are calculated as $1 - e^{-a}$, where e is the base of the natural logarithms, and a is the (mean) number of spill contacts. This calculation assumes that the probability of a specific number of spills occurring and contacting land is governed (can be approximated) by a Poisson process (footnote 2).

which they may come into contact. The long-term potential cumulative effect of operational discharges and other small oil and hydrocarbon product inputs to the Gulf of Mexico is of concern. However, there is not a consensus at this time on the level of expected impact. It is noted that the amount of operational discharge for the tankering option being analyzed is miniscule in comparison to the current annual discharges related to crude oil import tankering and other marine sources in the Gulf.

Emplacement and Physical Presence of Facilities. Pipelining would require the emplacement of 30-40 miles of pipeline which could cause the short-term (less than one year) disturbance of up to 200 acres of bottom sediments. In addition, the physical presence of this pipeline creates the potential for some minor conflicts with commercial trawling, including potential damage and loss of gear.

3. At Port/Terminal Facilities

Pipelining does not involve offloading at a port or terminal facility; therefore, it would not be an impact producing factor in these areas.

Oil Spills (accidental). There would be a 2% chance of one or more large (1,000 bbls or greater) spills occurring during the offloading of the shuttle tankers at port/terminal facilities or during their transit to these facilities through inland waters (i.e., estuarine areas, bays, harbors, navigation channels, or as in this case the Mississippi River). In addition, it is probable that a number (possibly 20) of smaller spills (1-999 bbls) could occur during offloading operations. It is likely that about 80% of these spills would be less than 10 bbls. Should one of these spills occur while offloading, it is assumed that it would be effectively contained and cleaned up before reaching a sensitive environmental resource. It is also assumed that any affected public water supply intakes would be boomed so that the oil spillage would not enter the system. However, there is a possibility that a large spill (less than a 2% chance) and several smaller spills could occur and contact sensitive resources over the 15-year production period. The expected level of local impact of these spill contacts is estimated to range from very low to high depending on the specific resources affected and other circumstances of the actual impact causing events.

4. Summary

The small amount (and other characteristics) of the operational discharges assumed to occur as a result of tankering are expected to have a minimal adverse impact. The 30-40 miles of new pipeline emplaced under the pipelining mode are also expected to cause minimal adverse impacts on sensitive resources.

The total mean number of large spill (1,000 bbls or greater) occurrences under both modes is fractional: 0.1 for tankering and 0.2 for pipelining. The probability of one or more such spill occurrences is 12% for tankering and 15% for pipelining, while the combined probability of a spill occurring and contacting land (within 10 days) is estimated at 6% for tankering and 8% for pipelining. A potentially significant difference between the two modes would be related to the size of the spill if it were to occur. The average size of a pipeline spill (1,000 bbls or greater) would be about 50% less than that for a tanker spill (25,937 bbls compared to 54,750 bbls).

Appendix I

Alternative Energy Sources as an Alternative to the Lease Sale

To delay or eliminate the proposed sales in part or in whole, would reduce future OCS oil and gas production in the short-term, necessitate escalated imports of oil and gas, and/or require the development of alternate energy sources to replace the energy resources expected to be recovered if the proposed sales take place.

The oil and gas that could become available from the proposed action over the time period could add to national domestic production. If these proposed sales were cancelled, an additive impact of greater oil and gas deficits could be expected to result in increased imports. If the subject sale were cancelled, the following energy actions or sources might be used as substitutes. However, some of these actions are not feasible at this time and may not be during the estimated life of these production areas.

It is anticipated that the oil and gas which would become available from these proposed actions in the assumed time period could provide a significant contribution to this region's energy supply; if the proposed actions were cancelled, the following energy actions or sources might be used as substitutes:

- energy conservation
- conventional oil and gas supplies
- coal
- nuclear power - fission
- nuclear power - fusion
- oil shale
- tar sands
- hydroelectric power
- solar energy
- energy imports
  - oil imports
  - natural gas pipeline imports
  - liquefied natural gas imports
- geothermal energy
- other energy sources
- combination of alternatives

This section briefly discusses these alternatives. For more detailed information on each of these energy sources and environmental effects, refer to *Energy Alternatives: A Comparative Analysis* (University of Oklahoma, 1975), prepared for the Bureau of Land Management by the Science and Public Policy Program of the University of Oklahoma.

Energy Conservation: Vigorous energy conservation is an alternative that warrants serious consideration. Several studies have suggested that we could enjoy the same standard of living and yet use 30%-50% less energy than we do now (Lansberg et al., 1979). Aside from these savings, it is not widely recognized that wasteful consumption habits impose social costs that can no longer be afforded, as do pollution and an inequitable distribution of fuel. Existing conservation programs include education, research and development, regulation, and subsidies.

The residential and commercial sectors of the economy are often characterized as inefficient energy consumers. Inadequate insulation, inefficient heating and cooling systems, poorly designed appliances, and excessive lighting are often noticed in these sectors. Reductions in consumption beyond those induced by fuel-price increases could be achieved by new standards on products and building and/or subsidies and incentives. Such incentives include standards for improved thermal efficiency in existing homes and offices and minimum thermal standards for new homes and offices.

Excessive consumption is also evident in the industrial sector, where energy-inefficient work schedules, poorly maintained equipment, equipment with extremely low-heat-transfer efficiencies, and unrecycled heat and waste materials are all commonplace.

Transportation of people and goods accounts for approximately 25% of nationwide energy use. Energy inefficiency in the transportation sector varies directly with automobile usage. Automobiles, which account for the bulk of all passenger movement in the nation, use over twice as much energy per passenger mile than buses do. Short- and mid-term conservation measures, such as consumer education, lower speed limits, and rate and service improvements on public transit and rail freight transit, may achieve considerable energy savings.

Other policies which could encourage fuel conservation in transportation include standards for more efficient new automobiles and incentives to reduce miles traveled. An important new development in the fuel economy area could be the modification of the standard internal-combustion engine. Although such an engine is now in the advanced stages of development, further study by automotive engineers, industry, and concerned Federal agencies is necessary before an acceptable engine can be designed.

Significant energy savings are clearly possible through accelerated conservation efforts. In addition, several of the strategies mentioned above have been at least partially implemented by the Energy Policy and Conservation Act of 1975 (P.L. 94-163).

Environmental Effect: The environmental effects of a vigorous energy conservation program will be primarily beneficial. The exact nature and magnitude of these effects will depend on whether there is a net reduction in energy use or whether the reduction is accomplished through technological change and substitutions. For the former, the net effects will mean that fewer pollutants of all kinds will be unleashed. As an example, a 2.2-million-barrel/day savings would result in a diminishment nationwide of various pollutants by the following amounts (HUD Contract #H2026R: "Research Evaluation of a System of Natural Air Conditioning"):

Pollutant	Amount of Pollutant per 1,000 Gallons (lbs)	Tons of Pollutant per Day
CO	4	189
Hydrocarbons	3	142
Particulates	23	1,088
NO_x	60	2,838
SO_x	157	7,426

However, if energy conservation is achieved by technological change or substitution, the net reductions also will be those above. Other effects could be related or attributed to an OCS lease sale in another unidentified area or as described below:

Conventional Oil and Gas Supplies: Reserves and undiscovered deposits of oil and gas still exist in the United States. Between 1955 and 1969, the United States had slightly increasing amounts of proved oil reserves of about 30 billion bbls. The discovery at Prudhoe Bay in 1970 raised the amount to 40 billion bbls, but reserves have been declining ever since. Since 1970, new oil discoveries have replaced less than half of production. Reserves are currently at the lowest level since 1951. United States production has been fairly constant since the mid 1960's at 8-9 million bbls daily. Similar patterns occur for natural gas. Proved reserves are currently estimated at 31.4 billion bbls of oil and 208.0 trillion cubic feet (tcf) of natural gas.

Ultimately recoverable resources (all deposits known or believed to exist in such forms that economic extraction is currently or potentially feasible), in addition to proved reserves, are estimated to be about 82.6 billion bbls of oil (54.6 onshore/28.0 offshore), 13 years of consumption at current rates, and 593.9 tcf of natural gas (426.9 onshore/167.0 offshore). This estimate is rising over time, mainly because of higher prices and new discoveries in unexplored areas. Unconventional hydrocarbons and recovery methods, especially enhanced recovery, could more than double these figures. The amount of ultimately recoverable reserves will depend on price, technology, geological information, and public policy such as price controls, access to Federal lands, and environmental standards.

Petroleum production is severely constrained in the short run and greatly affected by world prices in the long run. Although the long-run demand for fuel liquids is not forecast to decline significantly (feasible solid and gaseous substitutes do not appear to exist), consumption of conventional crude oil is expected to decline significantly, as synthetic liquids are produced from shale, tar sands, coal; biomass sources are utilized; and industry and utilities reduce oil facilities and shift to coal and possibly nuclear power (Table I-1). Synthetic liquid from coal is expected to be the major source of liquid fuel by 2020, supplying 50% of all liquid fuel and 10% of all energy consumed. The following table displays the dimensions of the projected decline in conventional crude oil demand:

Table I-1

Projected U.S. Energy Production and Consumption by Type
1985-2020
Low Oil Price Scenario

	1985		1990		1995		2000		2010		2020		Avg. Ann Growth 1985-2000 (Percentage)	Avg. Ann. Growth 2000-2020 (Percentage)
	Quads	Percentage of Total Consumption	Quads	Percentage of Total Consumption	Quads	Percentage of Total Consumption	Quads	Percentage of Total Consumption	Quads	Percentage of Total Consumption	Quads	Percentage of Total Consumption		
Domestic Energy Supply														
Liquid Fuels														
Conventional Crude Oil[1]	17.8	22.3	16.7	18.7	16.5	16.7	16.1	15.1	12.5	10.1	7.9	5.6	-0.7	-3.6
Enhanced Recovery	1.2	1.5	2.0	2.2	2.9	2.9	3.3	3.1	3.7	3.0	3.0	2.1	7.0	-0.5
Shale Oil and Tar Sands	0.0	0.0	0.1	0.5	0.5	1.0	0.9	2.2	1.8	3.1	2.2	16.6	5.8	
Synthetic (from coal)	0.0	0.0	0.0	0.0	0.0	0.0	1.4	1.3	6.8	5.5	14.8	10.4	---	12.5
Liquids from Biomas	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.5	0.4	0.8	0.6	---	5.0
Total	19.0	23.8	18.8	21.1	19.9	20.2	22.1	20.7	25.7	20.9	29.6	20.8	1.0	1.5
Gaseous Fuels														
Conventional Natural Gas	17.1	21.4	16.1	16.1	15.9	16.1	11.3	10.6	8.7	7.1	6.3	4.4	-2.8	-3.0
Enhanced Recovery	0.0	0.0	0.0	0.0	0.0	0.0	5.6	5.3	7.0	5.7	7.6	5.3	---	1.5
Synthetic (from coal)	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.7	0.6	1.3	0.9	---	9.8
Total	17.1	21.4	16.1	18.0	15.9	16.1	17.1	16.0	16.4	13.3	15.2	10.7	0.0	-0.6
Coal[2]	22.8	28.5	30.3	33.9	37.9	38.4	38.0	35.6	47.7	38.7	59.5	41.8	3.5	2.3
Nuclear	5.6	7.0	8.0	9.0	9.1	9.2	11.1	10.4	16.3	13.2	19.1	13.4	4.7	2.8
Other[3]	3.4	4.3	3.6	4.0	4.1	4.2	10.2	10.0	13.5	11.0	18.4	12.9	7.6	3.0
Total Domestic Production	67.9	85.0	76.8	86.0	86.9	88.0	98.6	92.6	119.6	97.1	141.7	99.6	2.5	1.8
Imports														
Net Oil Imports	12.7	15.9	14.1	15.8	14.1	14.3	10.6	9.9	6.9	5.6	4.3	3.0	-1.2	-4.6
Net Gas Imports	1.5	1.9	1.1	1.2	1.3	1.3	1.0	0.9	0.4	0.3	0.1	0.1	-2.7	-12.2
Net Coal Imports	-2.2	---	-2.7	---	-3.6	---	-3.7	---	-3.8	---	-3.9	---	-3.5	-0.3
Total Net Imports	12.0	15.0	12.5	14.0	11.8	12.0	7.9	7.4	3.5	2.9	0.5	0.4	-2.8	-14.8
Total Consumption	79.9	100.0	89.3	100.0	98.7	100.0	106.6	100.0	123.2	100.0	142.3	100.0	1.9	1.5

[1] Includes NGPL.
[2] Does not include coal used for synthetic oil and gas
[3] Includes hydroelectric, geothermal, solar, wind, and biomass. Does not include liquids from biomass.

Source. Energy Information Administration

	1980	2020
Quads of Conventional Crude Oil Consumed	34	8
As Percentage of Total Energy Consumption	45%	6%
Quads of Liquid Fuel Consumed	34	30
As Percentage of Total Energy Consumed	45%	21%

Conventional natural gas consumption is expected to decline due to depletion, higher prices, and competition with synthetic gas from coal. Enhanced gas recovery from unconventional sources such as tight sands and Devonian shale is expected to make a significant contribution to gaseous fuel production, providing 50% of all gaseous fuel and 5% of all energy consumption by 2020. Ultimately recoverable reserves from such sources are estimated at 3,000 tcf. The following table displays the dimensions of the projected decline in gaseous fuel demand (Table I-1):

	1980	2020
Quads of Conventional Natural Gas Consumed	20	6
As Percentage of Total Energy Consumption	26%	4%
Quads of Gaseous Fuel Consumed	20	15
As Percentage of Total Energy Consumed	26%	11%

A detailed description of the crude oil and natural gas systems is found in Chapter 3 and 4 of *Energy Alternatives: A Comparative Analysis* (University of Oklahoma, 1975).

To substitute directly for the proposed actions, a combination of onshore and OCS production from other areas and continued foreign imports would be required to make up for the estimated total production of these proposed actions.

Environmental Effect: This substitution would entail environmental effects such as land subsidence, soil sterilization, and disruption of existing land-use patterns. Equipment failure, human error, and blowouts also may impair environmental quality. Moreover, poor well construction, particularly in older wells, and oil spills can result in ground- and surface-water pollution.

The water pollutants from onshore oil production are oil and dissolved solids. The amounts of each vary over a wide range. A summary of onshore oil pollutants is available in *Energy Alternative: A Comparative Analysis* (University of Oklahoma, 1975).

Air pollutants (particulates, NO_x, hydrocarbons, and CO) result from blowouts and subsequent evaporation and burning. These are generally insignificant, except locally. Onshore or offshore effects are basically the same.

Given the fact that onshore supplies are dwindling, users of hydrocarbons from these proposed actions would have to continue their reliance on other regions and foreign imports for needed oil and gas. The decline in these supplies, even with energy conservation, could mean industrial shutdowns, increased unemployment, higher consumer prices, and changes in the standard of living. The lack of natural gas will mean additional use of "dirtier" alternative fuels (oil and coal) with consequent effects on air quality and human health.

Coal: Coal is the most abundant energy resources in the United States. Proven domestic reserves of coal are estimated at 438 billion short tons. This constitutes over one-quarter of the known world supply, 80% of proven

United States fuel reserves, and 130 times the energy consumed in 1980. Ultimately recoverable reserves are estimated at 3.9 trillion short tons. A detailed discussion of the coal resource system can be found in Chapter 1 of *Energy Alternatives: A Comparative Analysis* (University of Oklahoma, 1975).

Coal production (18.88 quads), consumption (15.67 quads), and inventories (203.6 million short tons) were at record level sin 1980, mostly as a result of increased demand from the electric utilities, including the conversion of existing power-generating units from oil to coal. The 7% increase in coal production over 1979 is the main reason for the United States record energy production in 1980.

Although domestic coal reserves could easily replace the energy expected to be realized from the proposed actions, serious limitations to coal development exist. In many uses, coal is an imperfect substitute for oil or natural gas. In many other cases, coal use and production is restricted by government constraints, limited availability of low-sulfur deposits, inadequate mining, conversion and pollution-abatement technology, and the hazardous environmental effects associated with coal extraction and from electricity generation. Coal production is also threatened by a unique set of labor problems associated with mining, and new, strict standard for coal-mine safety.

Due to its relative price advantage over other fuels, competitive market structure, and large resource base, coal consumption and production are expected to increase significantly and become the primary domestic energy source in the future (Table I-1). Synfuels from coal also will be important (see below).

The Powerplant and Industrial Fuel Use Act of 1978 was designed to reduce petroleum and natural gas consumption and to encourage greater use of coal and alternative fuels. The Act prohibits all new electric powerplants and large industrial boilers (and existing ones after 1990) from consuming oil or natural gas as a primary fuel source unless an exemption is granted.

Although United States coal resources are very large, as with other extractable mineral fuels, there is some geographic dislocation. Most of our new low-sulfur coal is found west of the Mississippi River or in Alaska, far from industrial areas. Also, much of the western coal is in arid or semi-arid areas where scarcity of water could constrain development.

If an alternative to the proposed OCS sale is greater reliance on coal, it may be expected that mining would have to increase in western states to provide the necessary fuel resources.

Environmental Effect

Coal Utilization: Combustion of coal results in various emissions, notably SO_2 and particulates. If the expected production from these proposed actions are replaced by coal, there would be an increase in these pollutants, especially if coal is substituted for the natural gas presently used. Technology to control these emissions is available but has not yet been proven sufficient to be widely applied. The sulfur content of eastern coal varies considerably, but approximately 65% of the developed resources have a sulfur content exceeding 1%. Most of the United States low-sulfur content exceeding 1%. Most of the United States low-sulfur coal is located in the western states. Any large-scale shift to coal would require realization of emission regulations or improvement of technologies to convert coal to gaseous or liquid fuels.

Surface Mining: The primary effect of surface mining is disruption of the land. This affects all local flora and fauna and water quality, and it increases landscape problems due to erosion and mine runoff. Reclamation is difficult in the western states due to the lack of water to assist in revegetation. Other problems include acid-mine-water drainage, leaching from spoil piles, processing waste, and disturbances caused by access and transportation. Noise and vibration resulting from operations also can be expected. Finally, surface mining causes conflicts with other resource uses such as agriculture, recreation, water, and wildlife habitat.

The land use of strip mining ranges from 0.8 to 5.9 acres/10^{12} BTU extracted, depending on seam thickness and BTU content of the coal.

Underground Mining: Underground mining primarily affects land and water quality. The land effects are those that arise from subsidence, waste disposal, access, and transportation. Very little surface is disturbed. Subsidence can destroy structures, cause landslides and earthquakes, and disrupt groundwater circulation patterns. The amount of subsidence can be controlled by the mining method used and the amount of coal removed. The utilization of certain mining methods and the restriction of the amount of coal extracts can have detrimental effects on the economics of the operation.

Water quality is affected by both processing waste and the drainage of acid-mine-water into surrounding areas. These can be minimized through the proper methods of control both during and after operation. Waste piles can be replaced in the mine and entrances sealed. This also would help to minimize subsidence. Other pollution problems are those associated with road and coal dust and the like, but these are minimal and easily controlled. Other disturbing aspects of mining have much less of an effect in an underground mine. Working conditions of underground mines have been improved under the Federal Coal Mining Health and Safety Act of 1969, although further efforts are needed to reduce health hazards. This program has resulted in increasing costs of underground mining when compared to surface mining, which has even more severe environmental consequences.

Coal Transportation: The five major transportation systems (road, rail, water, conveyor, and pipeline) all have some adverse environmental effects. These include air and noise pollution, safety hazards, landuse conflicts, trash disposal problems, and aesthetic damage. However, since spill problems are not associated with coal, most of the effects can be controlled with greater care and consideration. A slurry pipeline also requires large supplies of water and must adequately dispose of this at the other end. Water availability is a problem in many areas of the United States, especially in the west where energy resources requirements will have to compete with existing commercial and private users for a limited and fragile resource.

Coal Conversion: Technology for conversion of coal into gaseous and liquid hydrocarbons has been established for several decades, and a number of relatively low-capacity commercial plants exist in various parts of the world. However, few cost-effective advanced technologies have progressed beyond the pilot-plant stage.

Numerous problems remain before commercial development of synthetic fuels from coal can proceed. The cost effectiveness of synthetic fuels from coal will depend on prices of other fuels, primarily oil and natural gas.

The Energy Security Act of 1980 created the United States Synthetic Fuel Corporation. The corporation is empowered to provide financial assistance to the private sector for commercial synthetic fuel projects. The goal of the corporation is to increase synthetic fuel production to the equivalent of at least 500,000 bbls of oil per day by 1987 and 2,000,000 bbls per day by 1992.

Control of adverse environmental effects will increase the cost of producing synthetic fuels. Possible constraints on development include: technological constraints; availability of skilled workers; available raw materials (coal, water, and steel); capital; institutional constraints; government policies (energy resource leasing, coal mining regulations, permit procedures, etc.); and the willingness of industry to invest in the development of new technologies.

Synthetic oil and gas could contribute substantially to energy supplies by the year 2000. The most important contributions would be high BTU gas from coal, synthetic crude oil from oil shales, and coal liquefaction. The success of these energy sources will depend on developing technology, the cost of the effects, and the cost of conventional oil and gas.

Coal Gasification: Gaseous fuels with low, intermediate, or high energy content can be produced. Low and intermediate gases are produced in a two-stage process involving preparation and gasification, and the output is utilized as feedstock for electric generators. A third process, "upgrading," is required to produce high BTU gas, which produces an end-product usable by the consumer.

Among low BTU gasification processes under development are: Lurgi, Koppers-Totzek (both in commercial use), Bureau of Mines Stirred Fixed Bed, and Westinghouse Fluidized Bed. Among high BTU gasification processes are: Lurgi High-BTU gasification process, HYGAS, BI-Gas, Synthane, and CO_2 Acceptor.

The environmental effects of coal gasification are those of mining plus those resulting from the production process. Gasification processes have lower primary efficiency than direct coal combustion; more coal will have to be gasified to reach an equivalent BTU output. However, it is likely that coal gasification will achieve primary efficiencies of 70%, which is about twice that of coal to electricity end use. Water effects of processing can be minimized by recycling and evaporation. However, large inputs of water are required for some of the technologies, thus creating the potential for conflicts in water-short areas. For example, a Kopper-Totzek gasifier producing 250×10^9 BTU per day will require water in the amount of 463,000 gallons per day and coal in the amount of 10,570 tons per day.

Air pollution could include sulfur dioxide, particulates, nitrous oxides, hydrocarbons, and carbon monoxides. Land effects results from solid-waste disposal plus land use for the plant, coal storage, and cooling sands, etc. Solid wastes include ash, sulfur, and minute quantities of some radioactive isotopes.

Coal Liquefaction: Liquified coal has the potential to replace conventional crude oil as the major source of liquid fuel and provide 10% of total domestic energy consumption by 2020 (Table I-1).

As with coal gasification, production of liquid fuels from coal requires either the addition of hydrogen or the removal of carbon from the compounds in the coal. Coal liquefaction can be accomplished by hydrogenation, pyrolysis, or catalytic conversion. Only catalytic conversion is in commercial operation. Among liquefaction processes under development are: synthoil, H-Coal, Solvent Refined Coal, Consol Synthetic Fuel, COED, TOSCOAL, and Fischer-Tropsch.

Again, the effects of liquefaction will be those of mining and those of the processing plants. The available technologies have a recovery rate of from 0.5-3 bbls of oil per ton of coal processed.

Water effluents from liquefaction plants could contain amounts of phenols, solids, oil, ammonia, phosphates, etc. The waste water could be treated to remove most of these products.

Air pollution could result from particulates, nitrogen, sulfur oxides, and other gases. Pollution-control facilities would be required but would lower the economic attractiveness of the plants.

Solid wastes would be mostly ash. If liquefaction plants were sited near mine openings, residue could be buried in the mines with little further environmental effects.

Nuclear Power - Fission: The predominant nuclear system used in the United States is the uranium-dioxide-fueled, light-water moderated, and cooled nuclear power plant. Research and development is being directed toward other types of reactors, notably the breeder reactor.

Between 1970 and 1980, nuclear energy production increased from 21.8 billion kilowatt hours (1.4% of total United States electricity production and 0.4% of total energy production) to 251.1 billion kilowatt hours (11.0% of total United States electricity production). Installed generating capacity increased from 6.5 million kilowatts (1.9% of United States total) to 56.5 million kilowatts (9.2% of United States total).

Due to environmental concerns, the growth of nuclear energy may be slowing. At the end of 1980 there were 75 reactors in the United States, up to 19 in 1970. Although 4 reactors were licensed in 1980, 14 other planned units were cancelled, and the Nuclear Regulatory Commission closed 5 for modification to comply with revised seismic requirements and shut down 8 reactors comparable to Three Mile Island's to determine the probability for a similar accident and to make required safety modifications. Nuclear-energy output was down 1.6% in 1980. There are currently 102 reactors under various stages of construction, construction-permit review, or on order. Nuclear power development has encountered delays in licensing, siting, and environmental constraints as well as manufacturing and technical problems.

Future capacity will be influenced by the availability of plant sites, plant-licensing considerations, environmental factors, nuclear fuel costs, rate of development of the breeder and fusion reactors, and capital costs.

Domestic uranium resources are probably plentiful. Ultimately recoverable reserves are estimated to be 6,876 million short tons, and large areas are unexplored. Twenty-one million short tons were consumed in 1980 domestic nuclear energy production.

Although fuel-cycle costs of nuclear reactors have increased only slightly in recent years, present trends in reactor capitol costs are significantly narrowing the economic advantage offered by fuel-cycle costs over coal- and oil-fired plants. Nuclear energy may provide up to 19 quads in 2020 and 13% of total domestic consumption (Table I-1).

Environmental Effect: Although nuclear plants do not emit particulates or gaseous pollutants from combustion, the potential for serious environmental problems exists. Some airborne and liquid radioactive materials are released to the environment during normal operation. The amounts released are very small, and potential exposure has been shown to be less than the average level of natural radiation exposure. The plants are designed and operated in such a way that the probability of harmful radioactivity released from accidents is very low.

Nuclear plants use essentially the same cooling process as fossil-fuel plants and thus share the problem of heat dissipation from cooling water. However, light-water reactors require larger amounts of cooling water and discharge greater amounts of waste heat to the water than comparably sized fossil-fuel plants. The effects of thermal discharges may be beneficial in some, though not all, cases. Adverse effects can often be mitigated by use of cooling ponds or cooling towers.

Low-level radioactive waste from normal operation of a nuclear plant must be collected, placed in protective containers, and shipped to a Federally-licensed storage site for burial. High-level wastes created within the fuel elements remain there until the fuel elements are processed. Currently, spent fuel is stored at NRC-licensed facilities. Plans call for recovering unused fuels at reprocessing plants, solidifying the wastes, and placing them in storage at a Federal repository.

Primary residuals from light-water reactors are waste heat and radioactive emissions. For a 1,000 MW(e)-plant operating at a 75% load factor, a 33% efficient nuclear plant would emit 47 x 10^{12} BTU's of waste heat annually. For comparison, a 40% efficient fossil-fuel plant would emit 36 x 10^{12} BTU's of waste heat.

There are also effects on land, water, and air quality arising from the mining of these uranium ores. Dwindling amounts of high-grade reserves will increase the amount of land mined for lower-grade radioactive ores--primarily in western states. The mining operations will be similar to coal, but the nature and distribution of the deposits mean "lesser" effects while radioactive tailings cause unusual problems for disposal, the environment, and human health. A more complete discussion of uranium mining and processing, the economics and environmental impacts, as well as nuclear fission and fusion can be found in Chapters 6 and 7 of *Energy Alternatives: A Comparative Analysis* (University of Oklahoma, 1975).

Nuclear Power - Fusion: The controlled fusing of atoms in a reactor is a long-term alternative energy source. Scientific feasibility has yet to be proven but looks promising. Technological and commercial feasibility will have to follow, however. The main obstacles are obtaining a high enough temperature and containing the reaction. It is unlikely that fusion will be available to any significant degree before 2025.

Fusion is attractive for two reasons: abundant fuel sources and relative safety. The reaction is fueled by deuterium and tritium. Deuterium exists naturally in seawater and would be nearly cost-free. Tritium can be inexpensively produced in a reactor from lithium, which is plentiful.

Because of the small neutron activation involved in fusion reactions, there would be lower radioactive inventories, fewer radioactive wastes, and less serious fuel-handling problems and accident risks.

A proposed hybrid fusion-fission fuel cycle would fuel fission reactors with fusion-produced isotopes and multiply the energy release of fusion tenfold, while demanding less of the fusion core, thus enhancing the safety characteristics of both reactors.

A proposed pure deuterium process, while possessing a lower reaction rate, would have a neutron fuel cycle. Thus all particles and products would be electrically charged and there would, in theory, be no radioactivity.

Environmental Effect: The environmental risks from fusion energy are probably less than fission, but the degree of reduction, and the social acceptability of that degree, cannot be determine presently.

Oil Shale: Oil shale is a fine-grained, sedimentary rock which, when heated, releases a heavy oil that can be upgraded to synthetic crude oil. The technology for exploitation currently exists. The resource base for shale is very large, perhaps as much as 360 billion bbls.

Large areas of the United States are known to contain oil-shale deposits, but those in the Green River Formation in Colorado, Wyoming, and Utah have the greatest commercial potential.

Classes I and II deposits are at least 30 ft thick, average 30 gallons of oil per ton of shale, and include only the most accessible and better-defined deposits. Class III deposits are as rich as Classes I and II but more poorly defined and less favorably located. Class IV deposits are lower-grade, poorly defined deposits ranging down to 15 gallons of oil per ton of shale.

Environmental Effect: Oil shale development poses serious environmental problems. With surface or conventional underground mining, it is very difficult to dispose of the huge quantities of spent shale, which occupy a larger volume than before the oil was extracted. Inducing revegetation growth in an area of oil shale development is difficult and may take more than 10 years. In-place processing avoids many of these environmental hazards. With underground mining, the spent-shale problem is much less severe.

Air pollutants from the mining will come from dust and vehicular traffic. These will be predominantly particulates, followed by NO_x and CO, with minimal amounts o hydrocarbons, SO_x, and aldehydes.

The mining of oil shale requires little water, both for operations and for reclaiming solid wastes. Water pollutants are considered negligible but may arise if saline water was encountered during the operations and had to be disposed of.

However, the processing (retorting) operations of oil shale consume large quantities of water and generate large amounts of waste water. The waste water must be treated and can be reused in the process. Therefore, it has been assumed that water pollution will not be a problem outside the complex. However, the limited availability of input water in the development area could lead to resource-use conflicts.

Air pollutants vary with the technology used. Solid waste comprises the greatest problem of oil-shale processing. The volume of the waste is greater than the volume of the input. Therefore, backfilling and the like would not provide a sufficient disposal space. Finally, there are the effects of access and of transporting the products. These are analogous to those of coal mining in the case of access and petroleum distribution in the case of transporting the product.

A more complete description of this energy source can be found in Chapter 2 of *Energy Alternatives: A Comparative Analysis* (University of Oklahoma, 1975).

Tar Sands: Tar sands are deposits of porous rock or sediments that contain hydrocarbon oils (tar) too viscous to be extracted by conventional petroleum recovery methods. Large-scale production efforts have been developed in Canada, but United States ventures have been minor. United States' resources are concentrated in Utah, with some potentially commercial quantities in California, Kentucky, New Mexico, and Texas.

About 1.5 tons of rich tar sands yield about 1 bbl for tar, or bitumen, the equivalent of about 6.3 x 10^6 BTU's. Tar can be recovered either from sands mined on the surface or underground, or by direct underground extraction of the oil without mining. Recovery is followed by processing, upgrading to synthetic crude, and refining.

Ultimately recoverable reserves may be 100 billion bbls, including other heavy oils.

Environmental Effect: Surface mining produces substantial residuals, including modification of surface topography, disposal of large amounts of overburden, dust and vehicle emissions, and water pollution. Reclamation can minimize these effects. Residuals are similar to those of coal.

The effects of processing tar sands are similar to those of oil shale. These include solid tailings from extraction, cooling water and blowdown streams, thermal discharges, and off-gases. Under controlled conditions, these residuals can be minimized.

Underground extraction without mining can result in thermal additions, contamination of aquifers, surface spills, surface-earth movements, noise pollution, and emission of gases.

Hydroelectric Power: Hydropower is energy from falling water, which is used to drive turbines and thus produce electricity. Conventional hydroelectric developments convert the energy of natural regulated stream flows falling from a height to produce electric power. Pumped storage projects generate electric power by releasing water from an upper to a lower storage pool and then pumping the water back to the upper pool for repeated use. A pumped storage project consumes more energy than it generates but converts offpeak, low-value energy to high-value peak energy. A more detailed discussion of this energy source is found in Chapter 9 of the *Energy Alternatives: A Comparative Analysis* (University of Oklahoma, 1975).

Many of the major hydroelectric sites operating today were developed in the early 1950's. Thirty to forty years ago, hydroelectric plants supplied as much as 30% of the electricity produced in the United States Although hydroplant production has steadily increased, thermal-electric-plant production has increased at a faster rate.

From 1970 to 1980, hydroelectric power production has fluctuated slightly between 220 and 300 billion kilowatt hours, about 4% of total United States energy production. As a proportion of total United States electricity production and installed generating capacity, hydroelectricity has dropped from 16%-12%, although the latter has increased from 55.1-76.4 million kilowatts. Much of the recent hydroelectric development has been pumped-storage capacity.

It is likely that hydroelectric power will continue to represent a declining percentage of the total United States energy mix due to the following: high capital costs; seasonal variations in waterflows; land-use conflicts; environmental effects; competitive water use; and flood-control constraints. Sites with the greatest production capacity and lowest development costs have already been exploited.

Environmental Effect: Construction of a hydroelectric dam represents an irreversible commitment of the land resource beneath the dam and lake. Flooding eliminates wildlife habitat and prevents other uses such as agriculture, mining, and free-flowing river reaction.

Hydroelectric projects do not consume fuel and do not cause air pollution. However, use of streams for power may displace recreational and other uses. Water released from reservoirs during summer months may change ambient water temperatures and lower the oxygen content of the river downstream, adversely affecting indigenous fish. Fluctuating reservoir releases during peak-load operation also may adversely affect fisheries and downstream recreation.

Screens placed over turbines prevent the entrance of fish, but small organisms may pass through and may be killed.

Fish may die from nitrogen supersaturation, which results at a dam when excess water escapes from the draining reservoir. High nitrogen levels in the Columbia and Snake Rivers pose a threat to the salmon and steelhead resources of these rivers. Other adverse effects to water quality include possible saline-water intrusion into waterways and decreased ability of the waters to accommodate modate waste discharges.

Air quality will be affected only by dust and emissions during the construction phase. Afterwards, if the impoundment is used for recreation, motor exhaust would occur.

Solar Energy: Applications of solar energy must take into account the following:

-- Solar energy is a diffuse, low-intensity source requiring large collection areas. Only a small portion of the potential energy is utilized.

-- Its intensity is continuously variable with time of day, weather, and season.

-- Its availability differs widely between geographic areas.

Potential applications of solar energy show a wide range. Among them are:

-- Thermal energy for buildings
  water heating, space heating, space cooling, combined systems

-- Renewable clean fuel sources -
  combustion of organic matter
  bioconversion of organic materials to methane
  pyrolysis of organic materials to gas, liquid, and solid fuels
  chemical reduction of organic materials to oil

-- Electric power generation -
  thermal conversion
  photovoltaic - residential/commercial, ground central station, space central station
  wind-energy conversion
  ocean-thermal difference

Solar-energy-collection systems are now commercially available nationwide. Sales of collectors have risen from 1.2 million square feet in 1974 to 14.3 million square feet in 1979.

Environmental Effect: Although fuel costs for backup systems and maintenance costs for solar units are small when compared with operating costs of conventional heating and cooling systems, the high initial or "fixed" costs of solar units make them unattractive to many homeowners and builders. However, the rising cost of gas and oil needed by conventional heaters means that, over time, the greater fixed costs of solar systems will be balanced by their lack of fuel costs.

Large-scale generation of electricity using solar energy is another promising application which is receiving increased funding. A number of technical and engineering problems now prevent commercialization of solar-steam-electric plants, though pilot projects are well underway.

Additional detail on this resource alternative is found in Chapter 11 of *Energy Alternatives: A Comparative Analysis* (United States Government Federal Policy Task Force Review Group, Solar Energy Analysis, 1978; *Solar Energy Progress and Problems*, 1978, EPA, USDOE, and Lawrence Berkeley Laboratories et al.).

Among the disadvantages of solar energy are high capital costs, expensive maintenance of solar collectors, thermal-waste disposal, and distribution for local thermal balances.

The effects so far identified with solar energy are relatively minimal. The primary effects of the use of this energy source on a wide scale will be land use. Due to the low density of the energy, large areas will be necessary for the collectors. However, the land use compares favorably with other forms of energy use, such as coal extraction.

To date, the only other known area of concern is thermal pollution. Direct use in space heating has no thermal effects. However, for solar-electric-power generation, that will have to be collected and transferred to the generator.

Some localized thermal pollution may occur as a result, but the problem is not expected to be significant. Finally, solar plants can operate only intermittently. Thus, the energy will either have to be stored, or backup fossil-fuel plants will have to be built. These will have their own sets of environmental constraints.

Oil Imports: Spurred by new discoveries and competition, Middle East oil production expanded in the 1950's and 1960's. New markets were opened and prices softened. The real price of oil fell from 1948 to 1972.

Simultaneously, United States consumption of oil increased while production stayed constant; imports were relied upon to make up the difference.

In 1973, the Arab-Israeli war was accompanied by an embargo imposed by OPEC against nations supporting Israel. The vulnerability of the importers to their own heavy demand became evident, and a huge price increase followed. This marked the end of the so-called era of "cheap energy," and efforts were made to curtail imports. Another large price increase occurred in 1979.

Three avenues were pursued for reducing imports: conservation, or reduced net-energy demand per unit output; alternative energy; and increased domestic production. These are discussed elsewhere in this appendix.

The results of these efforts for reducing imports seem to have been mostly successful. The underlying market structure for energy has been altered. World demand for oil peaked in 1977 and appears to be in an irreversible structural decline. Gross national products have been rising along with nonenergy output, alternative energy sources, and non-OPEC production. Oil is wholly responsible for declines in energy use.

OPEC produced 32 million barrels per day (mbd) in 1977. Current projections of energy consumption until the year 2000 show rates of half of what was projected in 1972. The Department of Energy is currently projecting a 0.9% annual growth rate (actual growth was 1.9% annually from 1970-1979), and a 3% annual economic growth. The dimensions of the structural change for the United States in 1981 are as follows:

-- Total energy consumption is down 5%.

-- Petroleum consumption is down (8%) for the third straight year.

-- Oil consumption as a percentage of total energy consumption is down 9%.

-- Imports of petroleum are down for the fourth straight year. Imports in May 1981 were 5.2 mbd, the lowest in 10 years. This is 20% less than in 1980 and 38% less than in 1979.

-- Imported petroleum as a percentage of total petroleum consumption is down 5%.

-- Imported petroleum as a percentage of total energy consumption is down 27%.

-- Dollar of gross national product (GNP) has been steadily declining since 1970.

It is reasonable to assume OPEC will effect the bulk of the world's oil production for the remainder of the century, due mainly to the short-term in elasticity of the supply of substitutes, and set prices based on factors besides price/cost relationships. Brief derivations from this leadership position may be noted in the short-term due to world price adjustments. Thus, the less dependent the United States is on OPEC, the less vulnerable the United States is to large, erratic price changes. Imports from the Middle East also bring problems of stability of supply, balance of payments, currency exchange rates, and United States offloading capacity.

The United States will probably remain somewhat dependent on imported energy throughout this century and, as the 1970's showed, there are situations in the Middle East which could lead to major disruptions in supply or huge price increases. However, the propensity for such anomalies is less than in the past, due primarily to the following:

-- As mentioned above, the underlying market structure for energy has been altered and demand for oil has declined drastically. Associated with this, OPEC will have considerable spare capacity, and price cohesiveness will be difficult to maintain.

- All OPEC nations need to produce oil to finance development. The goal of many OPEC nations is to maximize oil's long-term contribution to the national economy rather than to maximize short-term profits. If revenue falls below a certain level where OPEC nations are not realizing an acceptable income, domestic tensions may ensue.

- The OPEC economies, especially Saudi Arabia's, are more interdependent with the West than previously. The OPEC has invested interest and financial reserves in the West, imports a large amount of goods from the West, and has its oil prices tied to Western currency-exchange rates.

- The presence of strategic stockpiles provides both a deterrent to international disruptions in world markets and a cushion for smoothing price and supply shocks. Current stockpile inventories of most Western nations are at record levels.

The OPEC's output and pricing structure also will depend on its balancing of:

- future vs. present proceeds;

- benefits vs. cost of rapid modernization; and

- discipline in the market vs. the political unit of OPEC.

Environmental Effect: The primary hazard to the natural environment of increased oil imports is the possibility of oil spills, which can result from accidental discharge, intentional discharge, and tanker casualties. Intentional discharges would result largely from uncontrolled unballasting of tankers. The effects of chronic, low-level pollution are largely unknown. The worldwide tanker casualty analysis indicates that, overall, an insignificant amount of the total volume of transported oil is spilled due to tanker accidents. However, a single incident such as the breakup of the *Torrey Canyon* in 1967 or the *Amoco Cadiz* in 1978 can have disastrous results. Of more concern than tanker spills is the effect on the social and economic environment. The potential for a future embargo under this option is such that American productivity and policy could become subservient to foreign influence, having both economic and security implications for the nation. On a more subtle level, political alignments and policies of the United States could become tied to those of foreign oil powers. This option is the least acceptable for continued American energy independence.

Natural Gas Imports: Imports of natural gas via pipeline have come largely from Canada, with small amounts also coming from Mexico. In 1980, net pipeline imports from Canada were 881 billion cubic feet, about 4.4% of the total natural gas used in the United States. These imports were about 33% of Canada's natural gas production.

The natural gas import situation continues to be highly uncertain. A major reason for this uncertainty is the disparity between prices for natural gas and alternative fuels in this country and the price of crude oil in world markets.

The United States and Canada concluded an agreement in March 1980 that established a formula for escalating the price of Canadian imports. The formula prices Canadian gas at the BTU-equivalent price of Canadian crude oil imports, minus an adjustment that reflect savings to Canada of certain transportation costs. In response to escalated Canadian prices, demand in the United States for Canadian gas dropped sharply. Consequently, Canada has foregone the opportunity to raise its export price. What modifications, if any, the Canadians will make to their pricing formula, and what minimum amounts of Canadian gas Americans must take under existing contracts, are matters currently being examined on both sides of the border.

Mexico could be a significant source of future imports because of its relatively large natural gas resource base. Imports form Mexico were of a local nature until 1957 and have declined since 1969. In September 1979, an agreement was concluded between the United States and Mexico regarding the importation and pricing of natural gas. A base price was specified to be escalated in proportion to the average price of five crude oils traded on the world market. However, the rapid increase in world oil prices between the time the agreement was concluded and the time the price escalation began brought the price of Mexican gas substantially below both oil parity and the Canadian gas price. Consequently, Mexico requested and received the same price as the Canadians.

Natural gas imports are expected to be eliminated in the long run, as domestic natural gas production will nearly satisfy decreasing demand, and synthetic gas from coal can provide the balance and replace imports.

Environmental Effect: The environmental effect of increasing gas imports derive mainly from the possible increase use of land for pipeline construction. A further effect is the risk of explosions and fires. Fluctuations of supply could influence quality of life, productivity, and employment. American policies also could become influenced by decisions of foreign gas producers; much as they could under the option of increasing oil imports.

Liquefied Natural Gas Imports: The growing shortage of domestic natural gas has encouraged projects to import liquefied natural gas (LNG) under long-term contract. Large-scale shipping of LNG is a relatively new industry. Several LNG projects are now under consideration on the Pacific, Atlantic, and Gulf Coasts. The security of foreign LNG is questionable. The complexity of the length of time involved in implementing these proposals has been increased by the need for negotiating preliminary contracts, securing the approval of the Federal Energy Regulation Commission and the exporting country, and making adequate provision for environmental and safety concerns in the proposed United States facilities. The authority to construct and operate facilities to implement imports and exports must be obtained separately from the Federal Energy Regulatory Commission. The cost of liquefying and transporting natural gas, other than overland by pipe, are high.

The United States imported 85 billion cubic feet of LNG from Algeria in 1978. In March 1980, Algeria announced that it was demanding oil-price parity, free-on-board, for gas it exported to the United States, and it subsequently discontinued deliveries. The free-on-board price does not include transportation, terminal, and regasification costs, which are substantial. Negotiations with the Algerians are in progress.

Environmental Effect: The environmental effects of LNG imports arise from tankers; terminal, transfer, and regasification facilities; and transportation of gas. The primary hazard of handling LNG is the possibility of a fire or explosion during transportation, transfer, or storage.

Receiving and regasification facilities will require prime shoreline locations and channel dredging. Regasification of LNG will release few pollutants to the air or water.

LNG imports will influence the United States balance of payments. This effect will depend on the origin and purchase price of the LNG, the source of the capital, and the country (United States or foreign) in which equipment is purchased and LNG tankers are built.

Geothermal Energy: Geothermal energy is primarily heat energy from the interior of the earth. It may be generated by radioactive decay of elements such as uranium or thorium, and friction due to tidal or crustal plate motions.

There are four major types of geothermal systems: hot-water, vapor-dominated, geopressured reservoirs, and hot-dry-rock systems.

In addition to electricity, geothermal energy can offer a potential for space heating, industrial processing, and other nonelectric uses in many areas which presently are highly dependent upon oil and gas for energy needs. However, geothermal-electric generating plants are smaller than conventional plants and require a greater amount of steam to generate an equal amount of energy. This is due to the fact that temperatures and pressures associated with geothermal areas are lower than those created at conventional power plants.

The greatest potential for geothermal energy in the United States is found in the Rocky Mountain and Pacific regions; some potential exists in the Gulf Coastal Plain of Texas and Louisiana. The geyser field in California is the most extensively developed source of geothermal energy in the United States It has been producing power since 1969. Exploration efforts are also underway in Imperial Valley, Salton Sea, Mono Lake, and Modoc County, California.

Between 1970 and 1980, geothermal production increased from 525-5,073 million kilowatt hours, and installed generating capacity increased from 84-1,005 kilowatts. Geothermal energy presently accounts for less than 1% of total United States energy production.

Environmental Effect: A number of gases are associated with geothermal systems and may pose health and pollution problems. These gases include ammonia, boric acid, carbon dioxide, carbon monoxide, hydrogen sulfide, and others. However, adverse air quality effects are generally less than those associated with fossil fuel plants. Also associated with geothermal energy systems are saline waters, which must be disposed of and isolated from contact with groundwater regimes.

Land quality problems stem from disturbance due to construction of related facilities and possible ground subsidence which, in turn, can cause structural failures and loss of groundwater storage capacity.

Other Energy Sources: The high cost and rapidly shrinking reserves of traditional energy fuels have encouraged research into new and different sources for potential energy. Some of these alternative sources have been known for decades, but high costs and technical problems have prevented their widespread use. They include tidal power, wind power, organic fuels, and ocean-thermal-gradients, among others. These sources are expected to account for up to 13% of total domestic energy consumption by 2020 (Table I-1). Environmental effects of these alternatives are difficult to assess, especially since a great amount of research and development remain to be completed before operational-scale systems can be developed, tested, and evaluated for production and application.

The date of commercial availability of such alternatives will depend on the cost of the traditional energy fuels, the level of Federally-subsidized research through Energy Research and Development Administration assistance, and the solution of engineering and technical problems.

Combination of Alternatives: A combination of some of the most viable energy sources available to this area, discussed above, could be utilized to attain an energy equivalent comparable to the estimated production within the anticipated field life of these proposed actions. However, this combination of alternatives, in order to attain the needed energy mix peculiar to the infrastructure of this area, would have to consist of energy sources attainable now or within the suggested timeframe that are transferable to the technology presently used. Viable substitutes would have to be available for the petroleum and natural gas required by the petrochemical industrial complex; the petroleum use for the transportation sector, and the electricity and fuels used in residential and commercial sectors.

Part II of the *Energy Alternatives: A Comparative Analysis*, particularly Chapter 16, "Comparing the Economic Costs of Energy Alternatives," discusses the factor that must be involved in developing technically and economically appropriate energy alternatives.

Tables I-2, I-3, and I-4 displays United States' production, consumption, and net imports of energy by type from 1970-1980. The most noteworthy change in energy to occur in the 1970's was the enormous increase in the prices of fossil fuels (Table I-5).

Table I-5

Prices of Domestically Produced Fossil Fuels
(cents[1] per million BTU's)

	1970	1980	Average Annual Increase	1960-1970 Average Annual Increase
Crude Oil	59.9	206.0	13.1%	-1.6%
Natural Gas	16.9	76.9	16.4%	-0.5%
Coal[2]	27.9	64.9	8.8%	-1.5%

[1] Constant 1972 dollars.
[2] Bituminous coal and lignite.

Source: Energy Information Administration

These price increases were caused mainly by the large increases in crude oil prices set by OPEC in 1974 (357%) and in 1980 (95%). The OPEC controls the bulk of the world's oil production and can set market prices based on factors other than price/cost relationships. Increases in the prices of substitutes, gas and coal, followed.

Thus, while the amounts produced, consumed, and imported did not change drastically (although crude oil consumption and imports did rise and fall), their value did increase substantially.

Table I-1 displays the Department of Energy's (1980) projections of domestic energy production and consumption by type from 1985-2020. DOE prepared three series of projections, each a function of a distinct time

Table I-2

U.S. Production of Energy by Type
1970-1980

	Coal			Crude Oil[1]			NGPL[2]			Natural Gas (Dry)		
Year	Quads	Percent of Total Production	Percentage Change from Previous Year	Quads	Percent of Total Production	Percentage Change from Previous Year	Quads	Percent of Total Production	Percentage Change from Previous Year	Quads	Percent of Total Production	Percentage Change from Previous Year
1970	15	24	---	20	32	---	3	5	---	22	35	---
1971	14	23	-7.1	20	32	0.0	3	5	0	22	35	0.0
1972	14	22	0.0	20	32	0.0	3	5	0	22	35	0.0
1973	14	23	0.0	19	31	-5.3	3	5	0	22	35	0.0
1974	14	23	0.0	19	31	0.0	2	3	-50	21	34	-4.8
1975	15	25	7.1	18	30	-5.6	2	3	0	20	33	-5.0
1976	16	27	6.7	17	28	-5.9	2	3	0	19	32	-5.3
1977	16	27	0.0	17	28	0.0	2	3	0	20	33	5.3
1978	15	25	-6.7	18	30	5.9	2	3	0	19	31	-5.3
1979	18	28	20.0	18	28	0.0	2	3	0	20	31	5.3
1980	19	29	5.6	18	28	0.0	2	3	0	20	31	0.0
Avg. Annual Growth			2.4%			1.1%			-4.1%			-1.0%

U.S. Production of Energy by Type
1970-1980
(continued)

	Hydroelectric Power[3]			Nuclear Electric Power			Other[4]			Total Energy Produced	
Year	Quads	Percent of Total Production	Percentage Change from Previous Year	Quads	Percent of Total Production	Percentage Change from Previous Year	Quads	Percent of Total Production	Percentage Change from Previous Year	Quads	Percentage Change from Previous Year
1970	3	5	---	0	0	---	0	0	---	63	---
1971	3	5	0	0	0	0	0	0	0	62	-1.6
1972	3	5	0	1	2	0	0	0	0	62	-1.6
1973	3	5	0	1	2	0	0	0	0	62	-1.6
1974	3	5	0	1	2	0	0	0	0	61	-1.6
1975	3	5	0	2	3	100	0	0	0	60	-1.7
1976	3	5	0	2	3	0	0	0	0	60	0.0
1977	2	3	0	3	5	50	0	0	0	60	0.0
1978	3	5	0	3	5	0	0	0	0	61	1.6
1979	3	5	0	3	5	0	0	0	0	64	4.9
1980	3	5	0	3	5	0	0	0	0	65	1.6
Avg. Annual Growth			0%			14.7%			0%		0.3%

Source. Energy Information Administration.

[1] Includes lease condensate.
[2] Natural gas plant liquids.
[3] Includes industrial and utility production of hydropower.
[4] Includes geothermal power and electricity produced from wood and waste.

Table 1-3

U.S. Consumption of Energy by Type
1970-1980

Year	Coal			Natural Gas (Dry)			Petroleum			Hydroelectric Power[1]		
	Quads	Percent of Total Consumption	Percentage Change from Previous Year	Quads	Percent of Total Consumption	Percentage Change from Previous Year	Quads	Percent of Total Consumption	Percentage Change from Previous Year	Quads	Percent of Total Consumption	Percentage Change from Previous Year
1970	13	19	---	22	33	---	30	45	---	3	4	---
1971	12	18	-8.3	22	32	0.0	31	46	3.3	3	4	0
1972	12	17	0.0	23	32	4.5	33	46	6.5	3	4	0
1973	13	17	8.3	23	31	0.0	35	47	6.1	3	4	0
1974	13	18	0.0	22	30	-4.5	33	45	-6.1	3	4	0
1975	13	18	0.0	20	28	-10.0	33	46	0.0	3	4	0
1976	14	19	7.7	20	27	0.0	35	47	6.1	3	4	0
1977	14	18	0.0	20	26	0.0	37	49	5.7	3	4	0
1978	14	18	0.0	20	26	0.0	38	49	2.7	3	4	0
1979	15	19	7.1	21	27	5.0	37	47	-5.7	3	4	0
1980	16	21	6.7	20	26	-5.0	34	45	-8.8	3	4	0
Avg. Annual Growth			2.1%			-1.0%			1.3%			0%

U.S. Consumption of Energy by Type
1970-1980
(continued)

Year	Nuclear Electric Power			Other[2]			Total Energy Consumed	
	Quads	Percent of Total Consumption	Percentage Change from Previous Year	Quads	Percent of Total Consumption	Percentage Change from Previous Year	Quads	Percentage Change from Previous Year
1970	0	0	---	0	0	---	67	---
1971	0	0	0	0	0	0	68	1.5
1972	1	1	---	0	0	0	72	5.9
1973	1	1	0	0	0	0	75	4.2
1974	1	1	0	0	0	0	73	-2.7
1975	2	3	100	0	0	0	71	-2.8
1976	2	3	0	0	0	0	75	5.6
1977	3	4	50	0	0	0	76	1.3
1978	3	4	0	0	0	0	78	2.6
1979	3	4	0	0	0	0	79	1.3
1980	3	4	0	0	0	0	76	-3.9
Avg. Annual Growth			14.7%			0%		1.3%

Source: Energy Information Administration.

[1] Includes industrial and utility production, and net imports of electricity.
[2] Includes geothermal power, electricity produced from wood and waste, and net imports of coal coke.

Table I-4

U.S. Net Imports of Energy by Type
1970-1980

	Coal		Crude Oil and Refined Petroleum Products[1]		Natural Gas (Dry)		Electricity		Coal Coke		Net Imports		Imports as Percentage of Total Energy Consumed	
Year	Quads	Percentage Change from Previous Year	Quads	Percentage Change from Previous Year	Quads	Percentage Change from Previous Year	Quads	Percentage Change from Previous Year	Quads	Percentage Change from Previous Year	Quads	Percentage Change from Previous Year	Percentage	Percentage Change from Previous Year
1970	-2	---	7	---	1	---	0	---	0	---	6	---	9.0	---
1971	-2	0	8	14.3	1	0	0	0	0	0	7	16.7	10.3	14.4
1972	-2	0	10	25.0	1	0	0	0	0	0	9	28.6	12.5	21.4
1973	-1	100	13	30.0	1	0	0	0	0	0	13	44.4	17.3	38.4
1974	-2	-100	12	-8.3	1	0	0	0	0	0	12	-8.3	16.4	-5.5
1975	-2	0	13	8.3	1	0	0	0	0	0	12	0.0	16.9	3.0
1976	-2	0	15	15.4	1	0	0	0	0	0	15	25.0	20.0	18.3
1977	-1	100	18	20.0	1	0	0	0	0	0	18	20.0	23.7	18.5
1978	-1	0	17	-5.9	1	0	0	0	0	0	17	-5.9	21.8	-8.7
1979	-2	-100	17	0.0	1	0	0	0	0	0	17	0.0	21.5	-1.4
1980	-2	0	13	-30.8	1	0	0	0	0	0	12	-41.7	15.8	-36.1
Avg. Annual Growth		0%		6.4%		0%		0%		0%		7.2%		5.8%

Source Energy Information Administration.

[1] Includes crude oil, lease condensate, imports of crude oil for the Strategic Petroleum Reserve, refined petroleum products, unfinished oils, natural gasoline, and plant condensate.

path (low, medium, or high) for the price of international (imported) oil. Even the low-price time series assumes (slight) real price increases (process rising faster than the general inflation rate); Table I-1 displays the low-price projections, given the considerations regarding OPEC's waning price-setting strength.

Allowing favorable technologies and economies, the most viable domestically available energy alternative would probably consist of: the use of coal, oil, shale, tar sands, and biomass to produce synthetic liquids; nuclear energy, and coal to compete for the utility market; and renewables to supply a sizable portion of total energy requirements. The environmental effects of each of these alternatives have been discussed briefly in the previous sections of this report. The rest will be a long-term energy-supply transition from crude oil and less dependence on oil imports. Such patterns will require new, efficient technologies, major capital investments, and a high rate of growth in coal production.

The future United States energy-source mix will depend on a multiplicity of factors: the identification of resources; research and development efforts; development of technology; rate of economic growth; the economic climate; changes in lifestyle and priorities; capital investment decisions; energy prices; world oil prices; environmental quality priorities; government policies; and availability of imports.

It is unlikely that there will ever be a single definitive choice among energy sources or that development of one source will preclude development of others. Different energy sources will differ in their rate of development and the extent of their contribution to total United States energy supplies. Understanding of the extent to which they may replace or complement offshore oil and gas requires reference to the total national energy picture. Relative factors are:

-- Historical relationships indicate that energy requirements will grow in proportion to the gross national product.

-- Energy requirements can be constrained to some degree through the price mechanisms in a free market or by more direct constraints. Operating to reduce energy requirements is through the substitution of capital investment in lieu of energy, e.g., insulation to save fuel. Other potentials for lower energy use have more far-reaching effects and may be long range in their implementation. They include rationing, altered transportation modes, and major changes in living conditions and lifestyles. Even severe constraints on energy use can be expected to only slow, not halt, the growth in energy requirements within the timeframe of this statement.

-- Energy sources are not completely interchangeable. For example, solid fuels cannot be used directly in internal combustion engines. Fuel-conversion potentials are severely limited in the short term, although somewhat greater flexibility exists in the longer run and generally involves choices in energy-consuming capital goods.

-- The principal competitive interface between fuels is in electric power plants. Moreover, the full range of flexibility in energy use is limited by environmental considerations.

-- Regulation of oil and gas prices lowered the price below the product level that refiners (and consumers) paid for domestic oil and prevented the incremental cost of all domestic producing fields from equating to the price of imports. This impaired the economy's ability to adjust to world energy prices: underproduction of domestic oil; overconsumption of imports; and impediments to alternative energy. Under deregulation, the real prices of oil and gas will be closer to the marginal costs of alternative energy.

-- A broad spectrum of research and development is being directed toward energy conversion--more efficient nuclear reactors, coal gasification and liquefaction, LNG, and shale retorting, among others.

Several of these could assume important roles in supplying future energy requirements, although their future competitive relationship is not yet predictable.

Appendix J

Key Word Index

A

Air Quality - 7, 14-16, 22, 43, 59, 83, 107-108, 131, 165-166, 197, 200, 240-245, 272, 278, 300-304, 325, 331
Archaeological Stipulation - 3, 6, 22, 39, 48-49, 55, 61, 64, 66, 260-261, 263, 276-277, 279, 281, 315-317, 329, 331
Area Identification - 39, 55
Artificial reefs - 26, 119, 152

B

Barrier islands - 7, 41-42, 58, 78, 83-89, 98, 119, 131, 155, 196, 199, 212-215, 267, 281-284, 309, 322
Biologically sensitive areas - 6, 15, 19, 23, 30, 48, 54-55, 59, 61, 63, 66, 77, 159, 199, 206, 210, 219, 221-222, 224-225, 234, 266, 271, 278-280, 285, 287-288, 290-291, 319, 332-333
Biological/Live Bottom Stipulations - 3, 6, 7, 21, 23, 39, 42, 45, 47, 54-55, 61-64, 66, 220, 223, 225-226, 228-231, 266, 271, 278-279, 281, 287, 290-291, 293, 324, 330, 332

C

Clean Air Act - 22, 27, 83
Clean Water Act - 27, 30, 237
Coastal and Marine Birds - 8, 44, 60, 98, 196, 197, 199-200, 250-251, 274-275, 278, 309-310, 327-328, 331
Coastal Zone Management Program - 11, 15-16, 19, 24-25, 105, 109, 171
Commercial Fishing - 8, 9, 26, 42, 44, 59-60, 89, 98, 100, 107, 117, 152, 169, 170-171, 185, 190, 196, 198, 201, 221, 224, 252-256, 266, 275, 278, 280, 287, 290, 306, 309-312, 328, 331, 333
Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) - 27, 29-30

D

Development Scenarios - 3, 39, 56, 135

E

Endangered and Threatened Species - 7, 9, 15, 25, 43, 60, 85, 97-98, 107-108, 181, 183, 197, 200, 245, 266, 273, 278, 304, 306-307, 310, 325, 331
Energy Policy and Conservation Act of 1975 - 36

F

Federal Water Pollution Control Act of 1972 - 27, 29, 35, 163, 165
Fishermen's Contingency Fund - 252-253, 278, 331
Flower Garden Banks - 3-5, 15-19, 31-32, 55, 59, 62, 64, 77, 90-91, 93-96, 135, 172, 222, 225, 280, 286-288, 290-293, 295, 319, 332

M

Marine Mammals - 9, 25, 43, 60, 89, 98-99, 197, 200, 247-248, 273-274, 306-307, 326-327
Military Area Stipulation - 3, 6, 9, 22, 39, 51, 53, 55, 64, 66, 331
Military Warning Area - 6, 9, 34-35, 52-53, 115, 117, 152, 279, 332

N

National Ambient Air Quality Standards (NAAQS) - 22, 83, 166, 197, 200, 240
National Pollutant Discharge Elimination System (NPDES) - 16, 19, 28, 156, 232, 237-238

O

Ocean Incineration - 6, 11-13, 23, 28, 33, 65, 152
OCS Lands Act (OCSLA) - 3, 13, 15-16, 21-23, 25, 27, 29-30, 32
OCS Orders - 14, 19-23, 28-30
Oil Spill Cleanup - 28-30, 42, 170, 201-206, 213

R

Recreational Beaches - 8, 44, 61, 119, 172, 180, 182, 196, 199, 201, 206, 212, 257-258, 266, 275-276, 279, 282
Recreational Fishing - 9-10, 26, 42, 59, 84, 89, 97, 119, 152, 169-170, 221, 224, 280, 287, 290, 306, 312-314, 328, 331, 333

S

Scoping - 5, 7, 8, 9, 10, 13
Seagrass Beds - 7, 10, 31, 47, 83-85, 89, 107, 181, 183, 196, 198-199,
Sea Turtles - 7, 10, 43-44, 60, 84-85, 97, 180, 182, 197, 200, 206, 248-249, 273-274, 307-309, 326-327

T

Tourist and Recreation Industry - 119, 201, 206, 257, 280, 333
Transportation Stipulation - 23

W

Water Quality - 7, 15, 42, 80-81, 107-108, 131, 156, 163-164, 196-197, 200, 232, 235, 237-240, 266, 272, 278, 295, 298-300, 324-325, 330
Wetlands - 7, 26-27, 35, 42-43, 58-59, 83-84, 88-89, 98, 107-108, 148-149, 152-155, 169-170, 185, 196-197, 199, 214-217, 219, 239, 247, 252, 267, 271, 278-279, 282-285, 306, 322, 328, 330-332

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